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ABSTRACT

The 21 papers in this volume were presented at the 1979 conference of the International Simulation and Gaming Association. Concerned with new simulation and gaming models and research findings, they emphasize the use of simulation and gaming techniques for analytical as well as communicative purposes. Specific topics covered include simulation/games in education and training in the following content areas: (1) social sciences, (2) medical training, (3) science education, (4) second language instruction, (5) art education, and (6) policy making. (See Volume I for additional papers from the conference.) (BK)

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HOW TO BUILD A SIMULATION/GAME

Proceedings of the 10 th ISAGA conference
8, 9, 10 and 11 August 1979, Leeuwarden, The Netherlands

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In the time I have available today, I hope to give you a brief overview of a game design problem and how it was solved. The finished game is entitled POMP AND CIRCUMSTANCE, and it is currently being used as part of several research projects in the United States, and in some teaching contexts with adolescents in and out of the classroom context. It has not been published, largely due to my busy schedule of the last year, but I hope that by late Fall arrangements will have been made for its publication and dissemination.

Let me begin by laying out the problem in its several dimensions. First, was the clear need for something new in the way of a pedagogical tool for sex education courses for adolescents 13-18 years old. Many factors in American society promote the use of effective birth control techniques. Contraceptives and contraceptive information are legally available, relatively inexpensive, and socially approved. Our culture generally supports the notion of limiting family size and spacing childbearing over time, while strongly disapproving of births that take place out of wedlock. Nevertheless, the illegitimacy rate--that is, the number of children born to unmarried females -- has increased dramatically in the past decades. For instance, among a random sample of women aged 15 to 19, there were about three times as many illegitimate births in 1970 as there were in 1940. About 400,000 illegitimate births were recorded in 1973, with half coming from teenaged mothers. Since a large number of out-of-wedlock pregnancies end in marriage or abortion, it is possible that as many as a half million teenage pregnancies per year occur in the U.S.

Some of the efforts to reverse this trend have focussed on making contraceptives more accessible to the adolescent, and on educating the potential contraceptive user. Some form of sex education is available in many secondary school systems. At present, however, these programs generally teach the ado-

Chapter 5 :

Simulation and Games in education and training.

5.1 In the social sciences

5.1.1 Dr. Cathy S. Greenblat, professor in the Department of Sociology, Douglass College, Rutgers University, New Brunswick, NJ, USA and dr. J. H. Gagnon, Departments of Sociology and Psychology, State University of New York at Stone Brook, USA. Dr. Linda R. Rosen, C. S. G., Enterprises, East Brunswick, NJ, USA.

Designing POMP and CIRCUMSTANCE : A case study.

POMP AND CIRCUMSTANCE is copyrighted to CSG Enterprises, 1978.
It was designed under partial funding by a Ford Foundation grant under the Ford and Rockefeller Foundations, Population Policy Research Program.

of female players in the game revealing sexual codes that would then lead to post-game negative consequences from male players. It appeared to us that we had a moral obligation to offer our players "privacy", considering the possible serious consequences of not offering such protection.

This, of course, left us with a dilemma. How could we have players participate in a simulation in which they would have to take actions and make decisions which would teach them about the social and personal factors which affect adolescent decision-making about sexual behavior and contraceptive use, which give them better understandings of the costs and rewards of decisions made, which highlight the risks of non-contracepted intercourse, and, at the same time, protect them from duringplay discussions in which they might feel very uncomfortable and post-play interactions in which their game revelations became a new variable?

Our solutions, I believe, have been remarkably successful. The main element introduced to deal with the problem of need to reveal one's values is that we have set the players into fairly stereotypical roles, giving them values that have been found through research to be typical of their gender and age. Of course many of the players diverge from these values in their own thinking. But decisions that are most "rational" in the game are so in terms of the assigned values. Thus at the end of play, a player can use as "protection" that I did that because it was consistent with what I was told to maximize.

The second element of "solution" is even more important: we have designed the game on a very high level of abstraction. Although it is possible to play it otherwise, in the typical form of play, players are not told in advance what the topic is or what the gaming symbols represent. The POMP in the title stands for Pre-Marital Pregnancy, and the title, too, is delilescent about the biological facts of reproduction and the hazards of pre-marital pregnancy, but neglect the student's personal concerns about sexual activity.

Often, both the students and the teacher are made equally uncomfortable by the discussion of sexuality within the traditional classroom format (assuming such discussion is even permitted by local authorities). Both student and teacher are understandably hesitant to reveal personal information, and so discussions of a deeply personal topic may become impersonal and detached from real-life problems. Considering the rising rate of teenage pregnancy, it appears that conventional forms of classroom sex education have made little impact on adolescent sexual or contraceptive behavior.

Our second problem, then, was how to design a game that would permit attention to personal and social factors involved in adolescent sexual and contraceptive decision-making. We were not concerned with describing the female anatomy or the reproductive process--topics covered moderately well in other manners.

Third, we believed the most important value of a game on this topic would be its potential for creating an environment for more relaxed discussion between students and teacher and among students. Thus we were not concerned with teaching many facts, but rather with presenting a set of general principles that would serve as the basis for discussion of personal values and dilemmas and possible modes of dealing with these.

The fourth concern is in some ways the obverse of the third. That is, we wanted to provide a vehicle for thinking about personal values and actions, but wanted to make sure that players were protected from revealing these if they did not wish to do so. Particular concern was with the possibility

The playing board consists of two concentric circles broken into thirty segments. Each segment contains dots of one or more colors. Dots with an X through them indicate that a chip of that color must be forfeited. Dots without an X indicate that chips of that color should be taken from the appropriate pile of chips on the board. There are also six yellow spaces, broken into sections A.B.C. and D.

The players move around the board on the black track between the concentric circles, using a single marker for the dyad. When they land on a particular space, the Outer Track player gains or loses what is indicated on the outer track, and the Inner Track player gains or loses what is shown on the inner track. If they land on a yellow space, they may play any one of their four options, although they must both play the same option.

To determine the number of spaces to be moved, each player throws one die. Then they must decide which of the two throws they will follow. For instance, if the Inner Track player throws a "2" and the Outer Track player throws a "4", they must move either two or four spaces. When there is a conflict as to the number of spaces to move, the dyad must reach an agreement before the move is made. Since there are more gains than losses on the board, it is usually to the players' advantage to reach an agreement as quickly as possible.

The game is structured such that Outer Track players will not score as high as Inner Track players unless they play what is referred to as "Playing the Yellows". Playing the Yellows will provide higher gains for the Outer Track players because yellow chips are worth more points for this group. Some Inner Track players will not realize that they have less to gain and more to lose by playing the yellows. Others will be induced to play the yellows by a partner's offer of red chips.

berately kept ambiguous. Instead, participants play with a set of abstractions, choosing partners, negotiating the balance of costs and rewards in partnerships, and making decisions about whether to engage in activities that offer high returns but contain risks of substantial loss. These risks can be avoided altogether or reduced by the expenditure of points and the willingness to interrupt play to perform a repetitious task. Dyads must also decide who will pay the costs and perform the task if risks are to be reduced.

Following play of the game, there is a discussion of how it was played and why: for instance, players are asked "Why did you choose A instead of B? How did you and your partner reach that decision?". Then players are told what the real-life parallels to game elements are. They engage in further discussion of the extent to which their decision-making and its consequences in the game simulate what we know about teenage sexual and contraceptive decision-making in the real world. Finally, discussion centers on these real-world issues, as players and the operator elaborate upon the model represented in POMP and CIRCUMSTANCE.

Let me take a few moments and describe the game in operation, to give you a better feel for it. Then I will return to the design problems and why we made the decisions you will see incorporated in the game.

As players arrive, they are divided into two equalsized groups, labelled as "Inner Track" and "Outer Track" players. They form dyads consisting of one member from each group, and are seated in pairs at the playing boards. Each board is equipped with chips, a marker, and two dice. Players are also given individual scoring sheets which indicate the different values of the four sets of colored chips. Finally, players are given an information sheet which explains how to "Play the Yellows".

At this point, let me return to the question of the model and the solutions to the problems posed in the beginning of the paper. An effective gaming-simulation must rest on a sound conceptual model of the referent system. POMP AND CIRCUMSTANCE is a gaming-simulation of adolescent decisionmaking regarding sexual activity and contraceptive use. It has been designed to model the types of negotiations that take place between dating males and females, the sexual decisions they must make, the factors that tend to discourage the use of effective contraceptives, and the high risk of pregnancy in noncontracepted sexual behavior.

The model we have used is presented in Chapter 7 of Life Designs: Individuals, Marriages, and Families, by John Gagnon and Cathy Greenblat, two of the designers of the current game. The third designer, Linda Rosen, is an experimental psychologist whose work has also been in the domain of sexual decision-making. In our view, adolescent sexual activity is influenced by a wide variety of personal and interpersonal variables. POMP AND CIRCUMSTANCE incorporates some, but not all, of these variables. For instance, we have focussed on four areas that are of concern to the adolescent: the desire for love and romance, peer approval, adult approval, and sexual gratification. We have assumed that these concerns are of differential importance to adolescent males and females. Males, for example, are thought to be most concerned with sexual gratification and peer approval, while females seem most concerned with love and romance, less concerned with peer and adult approval, and least concerned with sexual gratification. Of course, these differential value systems are based on stereotypes of male and female needs, and will not hold true for many adolescents. By making use of these stereotypes, however, we enable adolescents to participate in the game without forcing them to reveal their own personal value systems to the playing group.

Others will be pressured to do so by their partner's references to "everyone is doing it" or threats to seek a more compliant partner. Many players in both groups will want to play the yellows simply because it makes the game more interesting and exciting.

Playing Yellow A requires simply a decision to do so. Yellow B,C, and D require players to spend some time performing a task that reduces the risk of loss of points from the dice throw. Tasks for C and D are nog known as play begins. Many players do not play Yellow C and D during the initial rounds because they do not know what is involved, are hesitant to pay the cost, or do not want to take the time to complete these options.

Whichever form of yellow is played, the Inner Track player must throw both dice to see whether the pair is to lose points. A high proportion of those who play Yellow A will have a "bad throw". By the end of the game, many players will learn that it is most advantageous to play Yellow C or D. A few will decide not to play the yellows at all, while a few will continue to play the high risk Yellow A or B, trusting to luck.

After two rounds of play are completed, all scores are totalled and compared. Inner Track players are instructed to compare their scores with other Inner Track players, and the same is true for Outer Track players. Post-game discussion begins with players revealing how and why they made their decisions. The operator then uses a chart which shows what the game simulates. Players and the operator then discuss the parallels between the gaming-simulation and real-life factors effecting sexual decison-making. Depending on the context of use and the purpose of use, the operator may provide supplementary information and/or a reading list to the players following the discussion.

Figure 1

SYMBOLS IN "POMP AND CIRCUMSTANCE"

Inner Track Players	Adolescent females
Outer Track Players	Adolescent males
Red dots (chips)	Love and romance
Blue dots (chips)	Peer approval
Green dots (chips)	Adult approval
Yellow dots (chips) on white spots	Sexual gratification from necking and petting
"Playing the Yellows"	Sexual intercourse
Yellow chips from playing the yellows	Sexual gratification from intercourse
"Yellow A"	Non-contracepted intercourse: easy, no cost, nothing extra to do, high risk of pregnancy
"Yellow B"	Intercourse with withdrawal: no cost, difficult to do correctly, does not substantially reduce the risks of pregnancy
"Yellow C"	Intercourse with condoms: low regular cost, generally can be done successfully, takes time, substantially reduces risk of pregnancy
"Yellow D"	Intercourse with the pill: high initial cost for female (who most go to doctor, admit sexual activity, buy pills), then easy (must be taken regularly), reduces risk to very low.
Risks from dice throw	Chances of conception
Loss from "bad" dice throw	Pre-marital pregnancy: higher loss for Inner (female) than Outer (male) Track Players

Although the game incorporates the opportunity for players to make use of effective contraceptives (playing Yellow C or D) a great many players will fail to do so, particularly in the early part of the game. The reasons for failure to use contraceptives within the context of the game parallel many of the reasons for contraceptive failure in the real world. For instance, research has shown that many adolescents consistently underestimate the chance of conception from unprotected intercourse. In addition, many adolescents do not use contraceptives because they lack accurate information about when and how to use them, where to get them, and what "cost"--social as well as economic-- is. Teenagers also mention reasons such as "lack of spontaneity", difficulty in communicating with one's sexual partner, and fear of revealing sexual activity to disapproving peers and adults.

Since most sexual decision- making occurs within male-female dyads, we have structured POMP AND CIRCUMSTANCE as a game for multiples of paired partners. All negotiations and decisions take place within the dyad, with outside influences such as peers and adults represented symbolically on the playing board. This structure also permits game administration and the gaming atmosphere to be simple, with a minimum of movement and noise. Game players need leave their seats only when they have decided to "purchase" effective contraceptives. Game players may, however, attempt to change partners if they find their initial partner to be incompatible in some way.

Figure I shows what each of the symbols in POMP AND CIRCUMSTANCE represents.

5.2 In technical and management training.

5.2.1 Dr. C. Brand, Lecturer in Business Organisation, Management Centre, Brighton Polytechnic, U.K.

Approaches and problems in the design of complex portable games for management training.

Introduction

This paper examines approaches and techniques which can be used to design complex portable games without recourse to computerisation or other sophisticated hardware. Its findings are based on recent games design work undertaken within Brighton Polytechnic Management Centre. A case study approach is adopted, utilising three games widely employed in industrial and commercial management training: The Mapperly Management Game, The Brighton Conference Game and Exchequer are used to illustrate most of the techniques, though there is some reference to other games jointly designed by the author and Terry Walker.

To place the paper in perspective and illustrate the type of design activity undertaken at Brighton, it is useful to provide a brief background to this aspect of the Management Centre's work. In the late nineteen-sixties, original work concentrated on computerised, manufacturing orientated, model based games. Current work spans a far wider spectrum, and games and simulations are incorporated in virtually all full and part-time courses offered by the Centre. Some members of

We feel that the game is best played in its abstract version for several reasons, all suggested in the beginning of the paper. First, since adolescents often feel embarassed or uncomfortable in open discussions of sexuality, playing the game abstractly permits them to participate in a relaxed, non-stressful situation. Second, players can participate in this game without revealing their own personal sexual beliefs and behavior. If players were informed before the game started, for example, that "playing the yellows" meant having sexual intercourse, many of them might alter their game-playing strategies to fit how they think they "should" play. Rather than forcing players to reveal or pretend their sexual values, we have opted to portray sexual activity as a set of standardized "costs", "gains", and potential "losses". At the same time, I can report that dr. Susan Philliber at Columbia University College of Physicians and Surgeons has been running the game for the past year; in fact, it was designed under a sub-contract through her office from a Ford Foundation grant. She has been using the version in which players are informed in advance about the topic and the meaning of the symbols, and she has a preference for this version.

Use of the game for both teaching and research purposes is just beginning. Thus we have at present only anecdotal data about its effectiveness. Personal observations and players' reports are extremely positive, leading us to high expectations about the utility of POMP AND CIRCUMSTANCE for sex education programs for adolescents.

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staff engage in considerable game based consultancy. Specifically, bespoke games are designed for individual organisations; game based courses are produced and operated; and games are operated as part of wider management training programs. The three case study games were originally designed as consultancy assignments to meet training needs defined by client organisations. Discussions with clients almost inevitably stressed the need for realism, complexity and the ability to challenge participants, while emphasizing the necessity of retaining portability as a game characteristic. Portability was required to give flexibility of operation, including the ability to utilise the game without location as a constraint. In practice, easy and inexpensive access to computing facilities has rarely been a characteristic of the sites used to operate the case study games.

Though the paper specifically covers techniques for increasing the portability of complex games designed for management training, many of the methods discussed are more generally applicable and may be utilised in other gaming fields. The section below provides a brief description of the three case study games, after which the various techniques used to incorporate complexity into the game design are discussed. These are associated with three major elements of a game; the game package, the game's models and the methods of deriving results. Each is examined separately.

The case study games

This section provides a brief description of each case study game. The Mapperly Management Game and Exchequer are model based games, the former is a "traditional" management game, and the latter allows participants to manage a simulated United Kingdom economy. The Brighton Conference Game utilises very different concepts, forcing participants to complete a complex, one-off and ill-defined task. All the case study games are commercially available through MAXIM Consultants.

The mapperly management game

This game was developed in 1977 in response to a request by a large manufacturing company for a strategic decision-making game for fifty managers. Since then its only alterations have been slight changes to its mode of operation and basic data. It has been used by numerous organisations, mainly on strategic decision-making courses or as a broadening exercise for single function based middle management. It is an interactive game where each participating team represents a company competing against a firm which is operated by the game organisers. Both companies manufacture and market monotrochs. (Monotroch is a pseudonym for the specific consumer durable product on which the game is based). The organisers operate a company called Kirkiton, and compete individually against each team using a predetermined strategy. This strategy is not revealed to participants but can be partially determined by careful analysis of the feedback information provided each round. This feature of the game requires teams to operate under conditions of considerable uncertainty and to examine the likely impact of their decisions upon Kirkiton's performance and competitive behaviour.

A number of market survey reports can be purchased which cover both companies performance, the market structure and the impact of different forms of competition. These enable teams to reduce uncertainty and operate with improved information levels. The game is biased towards marketing but is general management in nature including marketing, production, personnel and finance decisions. Among the issues it raises are competitive strategy, pricing policy, advertising policy, product mix, output levels, capacity utilisation, production costs, the allocation of overheads, manning levels and profitability. The game is typically played for five decision periods over an eight hour day, and performance is judged by cumulative profit combined with market penetration. Its unique form of competition means there is no upper limit on the number of participating teams.

The Brighton conference game

This game was originally designed in December 1977 as an integrating device on a general management course for local authority youth and community workers. It had to reinforce the problem-solving, communications and administrative skills learning objectives developed throughout the course. The nature of participants placed stress on the viability of finalised conference arrangements rather than financial aspects of the game. The final version of the game, developed for a major packaging company, places emphasis on both the financial and practical aspects of conference arrangements.

In the Brighton conference game, each participating team is given the task of organising a major conference (for about 400 delegates) in the Brighton area. Each time the game is played, the conference title and list of potential speakers can be changed to reflect the interests of the participant organisation. Essentially, each team has to organise a suitable conference venue, delegate accommodation in Brighton, design a conference programme, obtain speakers, market the conference to attract delegates and plan the conference finances in order to meet the profit objective. Marketing aspects include the production of a conference brochure and the design of an advertising campaign. The game is unusual because it actually forces each team to accomplish the full range of tasks outlined above. The game organisers will play the role of any individual or organisation that teams may wish to contact, whether it be hotels, conference venues, speakers or the local police. Teams organise their conference through the game organisers by 'phone or letter'. It takes approximately eight hours to play and a practical upper limit would be about 50 participants.

Exchequer

This game was developed during the early months of 1979 at the request of Bowaters Cartons Ltd., to provide a group of their senior managers with a greater understanding of the economic system in which they operate. It is an economic policy-making game and participants manage the United Kingdom economy during the five year lifetime of a parliament. It was modelled on the United Kingdom economy at the beginning of 1979 and so teams have to grepple with an economy with ten percent inflation, six percent unemployment, a hostile industrial relations climate and moderate successes in economic growth and balance of payments.

Teams pursue the objectives economic of growth, stable prices, favourable balance of payments and acceptable levels of unemployment. To achieve these objectives, they can utilise fiscal policy, monetary policy or direct controls, including prices and incomes policy or import controls. They affect the economy by influencing the aggregate levels of the major macroeconomic variables which combine to form gross national product.

Exchequer takes approximately a day to play and is the most complex manually driven game designed by the authors.

The game package

Five techniques are examined in this section: the incorporation of case studies in participants' notes; a modular approach to games design; introduction of market research options; provision of two stage feedback; and use of forecasting. In practice, each technique can be designed to simplify or complicate issues raised for participants. For example, a recent design brief proposed to develop a suite of games aimed at participants with different levels of ability, but incorporating identical settings and core concepts. In the game's simplest version a case study is included which explains and illustrates many complex interrelationships explored by participants in its more sophisticated version.

Use of case studies

In many traditional, model based management games, participants have the task of operating a company which in reality is no more than a statistical shell. Data is provided covering the production, finance, marketing and personnel constraints pertaining to the game's starting position. As there is no historical context, participants manage a company with a neutral personality whose development is totally dependent on their attitudes and decisions. The resultant lack of realism can lead to rejection of the game by some players.

A case study type introduction to the game can help resolve this issue. In Mapperly, this technique is used to place the game in a realistic market and competitive context, provide participants with a perceptual framework in which to operate, and to raise a number of complex problems which require consideration. It achieves these goals by presenting a statistical and narrative history of the products, structure of competition and companies involved in the game. It enables participants to formulate the character of the company they operate by providing information covering such areas as historical approaches to competition, marketing strategy, quality assurance and the regulation of its product range. A successful case study analysis will inevitably provide a valuable input during detailed consideration of the most appropriate strategies to be followed by Mapperly throughout the game. It will also aid participants interpret their results.

As Exchequer examines the management of the U.K. economy, most participants do not play the game in a perceptual vacuum, but have previously adopted a relevant (if not appropriate) set of attitudes, beliefs and values towards the issues raised within it. Part of the purpose of Exchequer's case study material is to provide an analysis of the U.K.'s economic performance against which these can be tested. This analysis presents a five year history of performance in economic growth, inflation, employment, and balance of payments. When operating Exchequer, we have discovered participants find such data inherently fascinating, and it provides a major motivational factor which lifts the game from the isolated world of the economists textbook into a real word situation. It is also central to the learning process, in that it provides an introduction to the areas of economic policy listed above, the tools of economic management and the economic variables government attempts to manipulate. By forcing participants to consider these issues as a coherent whole, it greatly increases the complexity of the game.

The case study approach has one major problem. It tends to speed a game's obsolescence whenever it needs to incorporate accurate and up-to-data statistical information. While this presents a particularly difficult problem for Exchequer, it is largely overcome in Mapperly. In Penetrate (a recent derivative of Mapperly) all financial data is presented as a continuing sequence but in a year independent manner.

A modular approach

A modular approach to games design can be used to greatly extend a game's flexibility, and the range and complexity of the problems associated within it. For example, the Brighton conference game is essentially packaged in a loose leaf format. Whenever the game is played, participants receive a core document stating their central tasks, method of play and game constraints. In contrast, the conference theme, and list of potential speakers is normally designed to reflect the interests of the particular group. (The commercial package contains a number of possible conference themes and speaker lists, plus instructions on their adaption to meet specific needs). The core game complexity can be increased by incorporating one or more options. Teams can be required to produce detailed conference budgets by a specified time, and/or a financial analysis of their final arrangements. An In Basket exercise, raising a range of problems, can be introduced during the later stages of the game.

Amexia , a game specially commissioned by American Express for use in their European management training programs, adopts a similar approach. It simulates the operation of the American Express company in an imaginary European country. The game was designed as a core game plus a number of interlocking modules. The core game forces participants to make decisions involving a number of key aspects of the company's operation with market research as an aid. The highest level game is designed for senior management and incorporates conflict based role plays, plus the need to produce detailed forecasts of each decision's results. The role plays when combined with the diversity inherent in the core game add considerably to the complexity and challenge of Amexia.
The crucial advantage for increasing game complexity utilising this approach is that it places additional demands upon

game participants without placing similar demands on game organisers. As the method and time required for producing game results is unaffected, the technique does not impair game portability. The major implications for trainers lay in the area of feedback provision and observation skills. Naturally the problems raised by using supplementary modules must be covered in the feedback session associated with the game. In Amexia, the role play module places considerable additional demands on the group process observation, and group counselling skills of the trainer.

Market research options

Market research can be incorporated into a game to increase the realism and complexity of its market appraisal aspects. Reports can be either pre-prepared surveys not affected by the game's progress or reports which can be updated as a result of participants decisions. Mapperly utilised both types of report offering a choice of six market surveys. These are a historical market share analysis; a market trends report, examining demand at different price levels; the effect of advertising and sales promotion upon market demand; a market share analysis; a market status update report; and a report giving Kirkiton's General Strategy. This report is made available through industrial espionage. The market trends report examines overall market demand and though it is pre-prepared, a separate report relates to each period of the game. Bu contrast, the market status update report can be purchased each period, varies with decisions made throughout the game, and thereby enables teams to gain immediate feedback concerning the results of their decisions.

Mapperly uses market research to pose the following problems: the trade off between reduced uncertainty and increased market research expenditure; the value of particular reports in market appraisal; the trade off between increased information and time available to process it. Market research is a useful tool for increasing complexity without reducing portability because many surveys can be prepared prior to the game. They can be distributed during decision periods without impinging on the calculation of results, while reports requiring an update can be produced after other feedback is distributed.

Provision of two stage feedback

In most model based games, feedback is distributed to participants in a single batch after each set of decisions. As games require relatively immediate feedback to maintain motivation, the period taken to produce these results is the major limit to portability. Computerisation is the normal solution to prolonged calculation times, even though considerable flexibility is lost. In Exchequer the major problem in producing a manually driven game was the time taken to produce results. Though game organisers gained much material for the feedback sessions, play testing revealed the process of working through the algorithms was too lengthy. The play tests did slightly reduce the overall calculation time by revealing methods for rationalising some algorithms, but the time savings were insufficient. The provision of two stage feedback solved the problem. In the first stage, teams received a statement of their growth rate, unemployment levels, balance of payments and inflation, plus the position of a number of prime indicators, e.g. business confidence, industrial relations climate, and political popularity. This provides a sufficient base for participants to start work on their next decision, and leaves game organisers free to produce the second feedback stage. This consists of a statement of the distribution of national income between wages, rent and profits, and consumption, investment, government expenditure, exports and imports. It also provides a detailed breakdown of teams government income and expenditure as modified by their overall economic performances. The second stage feedback follows about ten minutes after the first. A similar technique has since been incorporated in Amexia, whereby teams receive a detailed information analysis five minutes after their first set of results.

One problem found in using this technique is a reduced time availability for observing participants playing the game. Organisers and participants perceptions of the reasons supporting particular decisions often vary considerably. It is particularly important when the game is played to improve group dynamics or leadership skills where observation is essential. Set against this, the writer finds that teams often resent observation, and immediately change their pattern of behaviour on being observed.

Use of forecasting

The use of forecasting is an important and simple technique for increasing game complexity with few repercussions for game organisers. Participants are required to produce a forecast of the results of their decisions when presenting their actual decisions. During the feedback session they also report on the main reasons for their forecasting success or failure. This technique was originated in the Brighton Conference Game when teams were required to present a conference budget approximately half-way through the game. It has since been used in Exchequer and Amexia. In the latter game, the sophistication of forecast required varies considerably with the level of the player. Where forecasting is used, it is interesting to note teams have been consistently optimistic in their projections. As yet no consistent pattern has emerged to explain such behaviour.

Development of game models

For a game to be successful, no matter whether it is model, task or situation based, it should be designed utilising a coherent and viable set of theory. If the theoretical accuracy of a game's models can be challenged, credibility will be difficult to maintain. Likewise, the practical context of any game used for management training should be well researched, and seen as realistic. Logic based games to develop problem solving skills may be an exception in terms of practical context.

The greater sophistication and diversity constructed into the models supporting a particular game, the greater the potential challenge and complexity provided for participants. The specific learning objectives for using a game will determine whether the full range and complexity of issues raised within it should be identified for participants prior to play. The use of valid, unambiguous theoretical models within games has the additional advantage of providing a clear and relevant basis for calculating game results rapidly, and therefore considerably aids portability. This section examines the game models utilised within the case study games.

The models in Mapperly

The theoretical element of Mapperly relies heavily on both Economics and Marketing. Specific areas utilised, include duopoly and oligopoly theory under conditions of product differentiation, price theory and theories of consumer behaviour. This section concentrates on the competitive aspects of Mapperly, and the manner in which oligopoly theory is translated into valid game models.

Specific form of competition. As stated above, Mapperly is an interactive management game where two companies are in direct competition. The significance of this form of competition is that the market strategies of one competitor will have a direct and measurable impact on the sales, profitability and likely strategies of the other company in the market. This model is attractive to game participants because they can relate it to many real world situations, and to game designers because outcomes can be modelled relatively accurately without recourse to computerisation. Splitting the market between the two companies can be achieved taking into account their specific pricing and promotional policies as modified by a sophisticated pattern of consumer preferences. This provides a highly challenging and uncertain environment for participants, and means the results of their actions can always be explained logically, using the practical application of theory used in the game. As the number of competitors increases, the theoretical validity of any allocation of market share becomes increasingly open to challenge, and less closely related to accepted theoretical norms.

When designing Mapperly, the form of competition was seen to present one potential problem. Participants might be less motivated competing directly against game organisers, but only indirectly amongst themselves. In practice this problem has never arisen.

Four product model. Both competitors produce two versions of the same product, of which one is a standard, and the other a luxury model. This complicates matters for participants as they must determine a product mix policy. This requires consideration of the relative profitability of both models, combined with a view of with which model they are best placed to exploit in the market. In fact the game contains a dilemma. The use of a contribution analysis shows the luxury product to be more profitable, while the case study reveals the company is best placed to exploit the standard market.

The problems posed for game organisers are much simpler. The game model first splits the overall market between the standard and luxury models, and then divides each model's demand between the two companies. This process takes into account relative prices and advertising, plus patterns of consumer preferences, and takes approximately two minutes per team to calculate manually.

The introduction of uncertainty. Oligopoly theory stresses the uncertainty inherent in such markets, a variety of potential outcomes, and the widespread use of managerial strategies aimed at reducing uncertainty. Each of these factors is designed within Mapperly. Teams receive little information concerning Kirkiton's strategies, or the effect of particular pricing or advertising strategies, but they can reduce uncertainty through purchase of market research, or by following policies of stability in the market place. No single strategy is always more effective, and policies of trading up, agressive price competition, agressive non-price competition and stability have all been utilised successfully.

The success of any strategy depends on participants belancing market demand with their projected output of each product, also taking into account the financial implications of their decisions. Hence the introduction of uncertainty places additional demands upon participants, without raising problems for portability.

The models in Exchequer

The models in Exchequer are more complex than those in Mapperly and incorporate a wider range of variables. To produce a realistic and workable game which simulates the operation of the United Kingdom economy, it was essential to utilise a firm foundation of macroeconomic theory. In practice, circular flow of income theory proved an ideal vehicle for gaming purposes. The central circular flow provides a core model into which other subsidiary models can be integrated. For example, an endogenous variable like swing can be simply incorporated as a function of gross national product. Individual models were constructed for each exogenous variable, and then linked into the main circular flow. For example, upper and lower limits were established for investment based on U.K. historical performance. Within these limits actual investment was established using a pay-off matrix linking business confidence and the interest rate. In turn, interest was set by government policy but modified by the rate of inflation, while business confidence was based on a combination of company profitability and the growth rate.

By using this approach each individual calculation remained relatively simple, and the total game can be operated manually. On the other hand, when all the models are combined together, the game presents a highly challenging and complex learning vehicle for participants. Trainers have found the manual calculations very useful for deriving cause and effect relationships within the game and for ascertaining reasons for individual teams performance. The resultant discussions form the basis for the review session following the game. Where participants have limited knowledge of economic theory, the feedback session attempts to reinforce the understanding of the variables within the game and the interrelationships between them. If participants have previously studied economics, the discussion is much wider ranging and emphasises that Exchequer presents one particular view of the operation of an economy and compares it with alternative perspectives available.

The models in the Brighton conference game

In both Exchequer and Mapperly, teams work towards completing a predetermined set of decisions which are processed through the game model to produce a set of results. The Brighton conference game is a task orientated game and utilises an entirely different approach. The game is presented to participants in terms of a series of outcomes they should achieve; i.e. a well organised, financially self-supporting, conference for four hundred people, taking place in Brighton in eighteen months' time. Participants can approach the task in any way they think fit, as long as all arrangements are conducted through the game organisers. As the game progresses, participants discover the constraints surrounding their tasks, e.g. type, cost and availability of conference venues and accommodation, availability of speakers, cost of advertising and so on. Any reasonable request will be met by game organisers, and in the past teams have visited hotel conference managers to discuss detailed arrangements, organised civic receptions or provided special entertainment for conference delegates. The Brighton conference game, therefore, incorporates a large number of simple and relatively independent models which can be activated by participants during the game. The major design problem in constructing these models was to identify the complete range of approaches which could be used to organise a conference, and devising methods to cope with them. Responses had to meet both highly effective and largely inappropriate attempts to undertake the task.

Four main techniques are used in the game. A databank is used to provide information. It is largely constructed in the form of brochures advertising conference venues, hotels, menus etc., and can be distributed to participants at their request. Standard letters cover requests for speakers, conference facilities and accommodation. These are pre-prepared

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and include confirmation of arrangements, provision of quotations and apologies for unavailability of facilities. Responsive role plays cover requests by telephone, speak to or to meet hotel managers, speakers, tour operators and so on. A participant 'phones the game organisers and asks to speak to a particular person. One of the game organisers then adopts that role and responds to any initiative. Control documents are used to record all agreements, whether written or oral, made between a participating team and game organiser. This enables organisers to verify the conference arrangements and their viability when teams present them at the end of the playing session. The game would not be viable without extensive prepared material and control documentation, as a single team generates considerable work for organisers.

The processing of game results

The time taken to process the results emanating from participants' decisions is a central issue relating to the portability of model based games. Normally, the more complex the game, the more complex the supporting models, the greater the number of variables requiring calculation and the longer the calculation period. Teams become demotivated if they have to wait too long for results. In both Mapperly and Exchequer, game models were designed to facilitate speedy manual calculation of results. The extensive use of algorithms and pay off matrices greatly facilitate this process. Both of these techniques are examined below.

The role of algorithms

The use of algorithms in the processing of the results of manually operated model based games has the following advantages: it provides a logical and rapid method for producing results; it ensures results are always calculated on a logical basis; it ensures all stages in the calculation process are completed; it incorporates all possible routes at each calculation stage; it provides the basic data for feedback sessions; a large number of factors can be incorporated in a single algorithm.

Mapperly uses two algorithms, one determining market demand, and the second the company's stock position and trading statement. Exchequer incorporates a major algorithm for determining the growth rate gained by each term, and a reries of shorter algorithms for other game variables.

The use of Pay-Off Matrices

Pay off matrices are extremely valuable in the development of game models as well as contributing to the rapid production of results. Their usefulness lies in the amount of data they can incorporate, and the ease with which information can be transferred into an algorithm. In Mapperly, pay off matrices are used to relate the relative prices charged by Mapperly and Kirkiton for their products, in the context of a specified pattern of consumer preferences. One matrix relates to the standard product, and the other to the luxury model. They are designed to reveal the following information:

- Mapperly will consistently achieve greater market penetration if it exploits the standard model.
- As the average market price of monotrochs rises, the market gradually shifts away from Mapperly towards Kirkiton.
- Kirkiton gains more from achieving a price (differential) advantage than Mapperly.

In Mapperly, these factors are modified by the cumulative advertising expenditure of Mapperly compared to Kirkiton. Flexibility is the great advantage of using pay off matrices. They are simple to substitute, and so market or other conditions can be changed as the game progresses. In Mapperly it would be possible to change consumer preferences between the competing companies products, or to modify the effects of a given price differential.

In Exchequer, the propensity to invest, save or import can be altered as the game progresses.

5.2.2 Professor ir. J. G. Balkestein, ing. F. L. Langemeijer, ir. J. H. Morreau, mr. P. J. J. Renders, Industrial Mechanisation and Mechanism Section, Department of Mechanical Engineering, Eindhoven University of Technology, The Netherlands.

Business simulation games in the training of mechanical engineers at the Eindhoven University of Technology.

1. Introduction and objective.

At the department of mechanical engineering of the Eindhoven University of Technology business simulation games are introduced to give the students an introduction to business situations. The simulations described in the paper, were designed by Prof. ir. J.G. Balkestein. They are:

- the planning simulation
- the marketing simulation
- the integral business simulation.

The try to give the student some idea of the aspects of:

- planning
- financial policy
- decision making
- the cohesion of various factors:
  - the launching of sales instruments
  - sale
  - costs and their influence on production

planning, sales
management and inventory control.

In general, these are aspects which are well transferable by way of simulations.

The student is placed in a situation in which he has to study the results of his actions and of his decisions. He has to do this together with other students. This enables him to acquire a first experience with business events in a simulated situation. The simulations should, especially in regard with this aspect, approach reality as closely as possible.

These simulations are not isolated, but are placed in a larger programme and their objective is to support the lectures in which the various aspects of technical management are discussed, such as:

- process analysis
- planning
- methods of costing
- annual accounts
- investment and deprecation problems.

Along with the gaining of knowledge about the subjects mentioned above, the development of analytical skill and the design of models (forms, lists and graphs) belong to the objectives; furthermore, stimulating interest in those aspects of technical management which, the student will have to deal with in the future.
In the April 1976 issue of "De Constructeur" the editors wrote as an introduction to an article of Dr. H.B.P. Jongsma of the N.V. Philips' Gloeilampenfabrieken 1 :

"Taking technical decisions is a design engineer's daily job. He is steeped in calculating with mechanical and physical quantities. But how different matters often are, when the consequences of a decision have to be translated into money.
The question "buy or make" of machine parts seems easy to answer. If it comes to establish the economical (if possible also the social) realizability of an investment many a design engineer will be inclined to deny himself to it".

Often a mechanical engineer (and certainly a works manager) will find himself in a situation in which he will have to make decisions based on technical and/or economical or financial arguments and that often in cooperation with staff employees of other disciplines. He has to see through the situation in which he finds himself, and in it he has to distinguish:

- the structure
- the carryings-on within the structure
- the various ways in which he can behave, take action and, in taking action, assess his task and that of others.

This is also mentioned in "Business Games, their Role in Training and Development" by F. Meurs and J.M. Choffray 2 .

The competition element, which is built into all simulations, will teach the participants to compete with each other by means of developing and working out a strategy. The student learns how to work in a team, to work out and to correct a strategy. Since it is questionable whether the participants have, at the start, a balanced and a well-defined strategy on which their decisions are based, there is a real posibility of developing strategies, because the simulations contain the inter activities and the dynamic aspects which are inherent in most of the business situations. An attempt should be made to establish a termplanning. The student, as well as the whole team, will have to collect the relevant information from the data obtainable from outside or which are furnished, or which can be obtained by developing models. He has to verify what information has to be transfered to the other team members.

Summarizing, the following can be mentioned as positive elements of these simulations:

- learning how to set up a term-planning;
- learning to see the complex relations existing in a concern, and so acquire a better insight into the combined actions of several management functions;
- acquiring experience in making decisions (often based on insufficient data), processing the consequences and being confronted with the uncertainty of the market mechanism;
- acquiring experience in performing a function (role-playing) in one of the functional segments;
- the student is being motivated for aspects of the technical conduct of business;
- acquiring a feeling for working under competitive conditions;
- teamwork promoting; learning to listen to and to take account of each other's opinions.

These elements are also mentioned in lit. 2 en 3 .

The aim of the simulation is didactic. The simulation ensures a unique possibility of evaluating the quality of the analytical efforts and model behaviour, because the team leader knows the simulated situation.

Since the introduction of business games in 1957 in the Washington University, as F. Meurs writes, more and more institutes have included such games in their curricula, whether or not in computer version.
At the Department of Mechanical Engineering at the Eindhoven University of Technology, the simulations are not realised by a computer but "by hand". A detailed argumentation about this will follow in chapter 6.

2. Programme.

The programme consists of 2 courses and 3 business games.

1. Course on "Introduction to the technical management" 4 (10 hours) with planning simulation belonging to it (4 afternoons) 5 ;
2. Course on "Technical management" 6
   (16 hours) with: - marketing simulation (3 days) 7
   and
   - integral business simulation (4 days) 8

   belonging to it.

The first course including the planning simulation is given in the second part of the bachelor programme of the mechanical engineering curriculum and is obligatory for all mechanical engineering students (appr. 75 participants every year).
The second course and the simulations belonging to it are among the optional subjects of the engineering programme. The number of participants is appr. 30 every year.

3. General design.

3.1 Some general remarks.

The sequence of the subjects is chosen so that the students are first confronted with a very restricted part of business policy, which is expanded later on.
In the planning simulation these are:
- production planning;
- capacity planning;
- offers (price and time of delivery);
- inventory control.

Next in the marketing simulation the accent is on:
- financial management;
- sales management (use of selling instruments).

The integral business simulation covers the whole of:
- purchasing (raw material);
- investments and writing-off;
- production planning and attuning the various business sections;
- inventory control;
- financial management;
- sales management (use of selling instruments).

The conceptions and defenitions which are used in the simulations, are dealt with prior to the courses. The subjects have already been mentioned in the Introduction. Exercises in the form of instructions, which have to be performed by the teams separately, have been built into the simulations.

3.2 The team.

The simulation games are played with 3-6 teams. Each team has 3-5 participants. Each team forms the management of a business firm.
Each industrial business produces the same products and has to try to sell these products in various markets. The models of the markets are discreet and have been adapted to reality as well as possible.
The teams must develop a strategy ensuring the best possible results.

Work is carried out according to a schedule fixed beforehand, but not known to the teams. Intermediate evaluations and a final evaluation have been built in. The teams work under a time pressure, which is sped up during the simulation, and by that the pace of the decisions is increased.
Before the start of the first period the teams are given ample opportunity.

- to gain insight into the business situation in which the team is placed;
- to establish the objective(s) of the business;
- to allocate the tasks;
- to find a proper form of cooperation;
- to make arrangements regarding decision forming;
- to create a strategy of management (including a range plan);
- to take the first steps in analysing the available data (including checking what information is needed and in what way it is to be obtained).

During the simulation the team has to check continually whether they are on the right way.

During the game, the actions regarding planning, purchase and sales, finance etc. have to be entered in the forms provided to the teams.
The forms are, however, not "complete" in the sense that the team have to design their own forms, graphics and lists for recording relevant data, which are needed for a good analysis and correct decision making.
In the beginning decisions will largely be based on a first rough prognosis.

As the insight into the situation increases, the results achieved will have to approximate more and more the prognoses that are based on analysis.

3.3 The leader of the team.

Each team is guided by a team leader. Starting from the results achieved, the worked out assignments and observations of the team leader - including those recorded in a contact intensity diagram (appendix 1) - the following questions are dealt with:

- does the simulation run well?
- is the strategy wrong of right?
  If wrong, why? And how may this strategy be adjusted?
- does everybody take full part and is the allocation of tasks right, or must it be revised?
- are data and information adequately processed?

This way of working has appeared to be very satisfactory.

The team leader is never allowed " to join in the game" and therefore has to conduct the team as "non-directively" as possible.

The other activities of the team leader are:

- watching over the fixed time schedule;
- maintaining contact with the central lead;
- attending the first policy discussions of the team and trying to prevent the teams from making mistakes at the very beginning, which would influence the simulation too drastically;
- checking all the forms of the team and copying all the necessary data on the forms that have been placed at his disposal.

3.4 The central lead.

The tasks are:

- providing information;
- checking and keeping up the time schedule;
- dividing the market potential;
- maintaining regular contact with the teamleaders;
- making graphics and tables from the data which are important to the intermediate and final evaluations.

4. Specific design.

4.1 The planning simulation.

Each team constitutes the staff of an industry which is placed under its control. The industry belongs to the type of "Job-shop" (many varied orders and means of production). The industries are subsidiaries of the main factory (see Figure 1).

The rule is that planning = production. In addition, each team receives a number of components (coloured plastic rings) as initial stock.
Figure 2 shows a model of the planning simulation, in which the tasks for the team are mentioned under I.

Model planning simulation

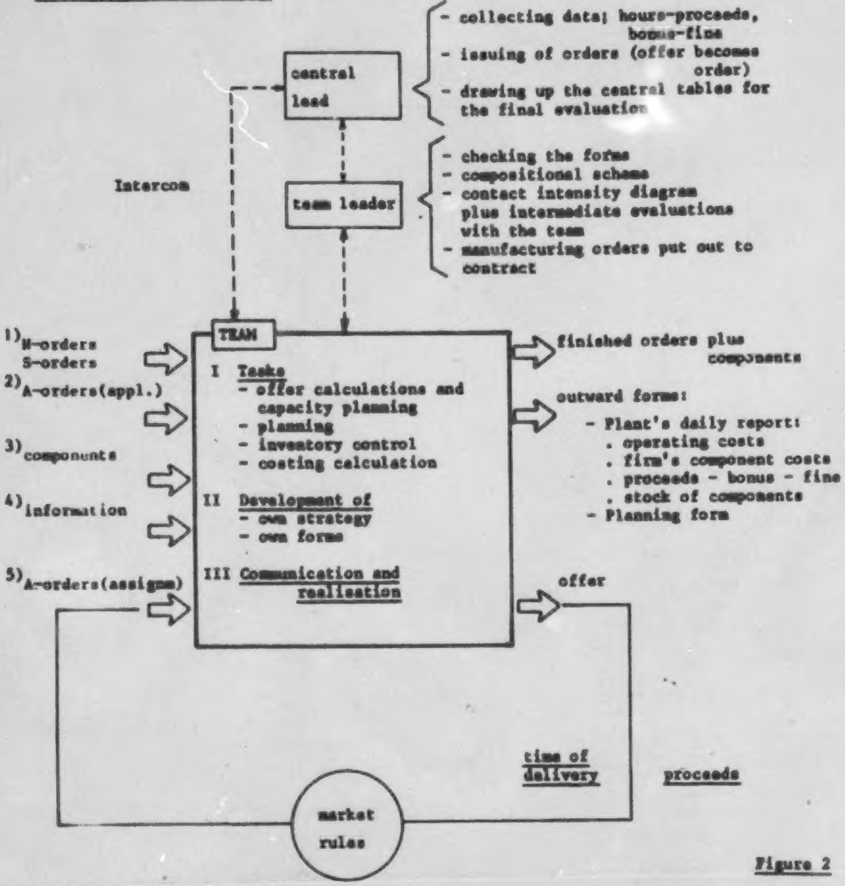
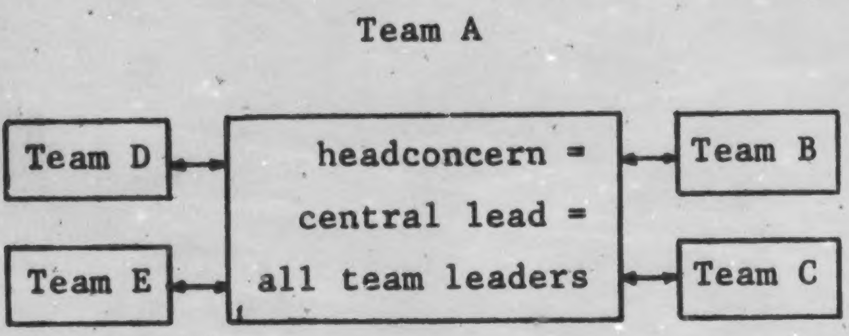

central lead
- collecting data; hours-proceeds, bonus-fine
- issuing of orders (offer becomes order)
- drawing up the central tables for the final evaluation
Intercom
team leader
- checking the forms
- compositional scheme
- contact intensity diagram plus intermediate evaluations with the team
- manufacturing orders put out to contract
TEAM
1) N-orders S-orders
2) A-orders(appl.)
3) components
4) information
5) A-orders(assignm)
I Tasks
- offer calculations and capacity planning
- planning
- inventory control
- costing calculation
II Development of
- own strategy
- own forms
III Communication and realisation
finished orders plus components
outward forms:
- Plant's daily report:
. operating costs
. firm's component costs
. proceeds - bonus - fine
. stock of components
- Planning form
offer
time of delivery
proceeds
market rules

Figure 2

(1) fixed number for each team
(2) the same orders provided to all teams by the main factory at the same moment
(3) the same quantity provided to each team by the main factory (central lead) and/or components produced by the subsidiary and those put out to contract
(4) components to be expected, list of worked hours and financial statement
(5) determined by the tenders



3 to 5 subsidiaries

Figure 1

Detailed production planning is dealt with. This implies that the orders provided or awarded to an industry have to be arranged over the machines and the time in as favourable a way as possible.
The number of ideal hours must be minimal. An important aspect of it is inventory control. The jig-saw puzzle planning is used.
Priority rules may be used:

1. Forward planning; starting from as early as possible a point of time and finishing the order within the fixed time of delivery.
2. Backward planning; starting from the extreme point of the time of delivery.

Each team is given an identical plan-board (Gantt-chart), on which the orders during one week (= 5 working days) can be planned.

The subsidiary (the team) acquires the orders in the following manners:

- N-orders (Normal orders): The subsidiaries receive a fixed block of orders from the main factory each week.
  Proceeds and time of delivery are fixed.
- A-orders (Application for offers): Each subsidiary receives the same applications. Time of delivery and price have to be fixed by the subsidiary itself.
- S-orders (Speed-requiring orders): These are distributed during the planning-period per order. Price and time of delivery are fixed.

For each order are given:

- order number plus the quantity that have to be made;
- process time per machine per part;
- the proceeds and time of delivery (N-orders, S-orders);
- bonus or fine per day, if the time of delivery is deviated from;
- the number of components per part needed for assembly.

Examples of the order-form and components-form are shown in figure 3.
For A-orders a corresponding form is provided, in which "time of delivery" and proceeds" have not been filled in.

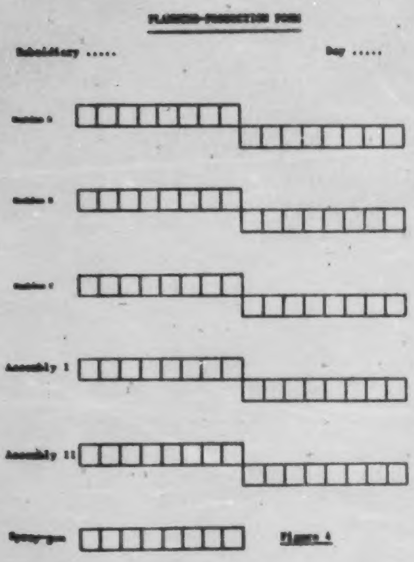
Order-number	quantity	time of delivery	1st process		2nd process		3rd process		4th process		assembly	spray-gun	proceeds	bonus/ day	fine/ day
			mach.	hrs/ part	mach.	hrs/ part	mach.	hrs/ part	mach.	hrs/ part	hrs/ part	hrs/ part			
R_7	2	t_1	C	2							4	2	1000,-	50,-	
R_9	1	t_2	B	3	A	4	C	1			3	1	850,-	50,-	
R_8	3	t_1	D	2	A	4	C	1	B	1	5	2	2200,-	100,-	
R_7	3	t_4	A	2	C	3	B	2			2	1	1650,-	150,-	150,-
R_2	5	t_5	C	2	B	1	A	3			3	1	2150,-	200,-	200,-

Order number	quantity	Number of components per part				
		X1	X2	X3	X4	X5
R_7	2	1	-	2	1	-
R_9	1	-	2	2	1	-
R_8	3	1	-	1	1	2
R_7	3	-	2	1	-	-
R_2	5	1	-	-	-	2

figure 3

At the end of each planned day (is worked day) every team has to hand over to its team leader:

- planning production form. This is a reproduction of the planned hours on the planboard (see figure 4);
- plant's daily report. This shows the operating costs, the proceeds (plus bonus c.q. fine), components consumption and the stock of components (see figure 5);
- the components for the assembly, planned on that day.

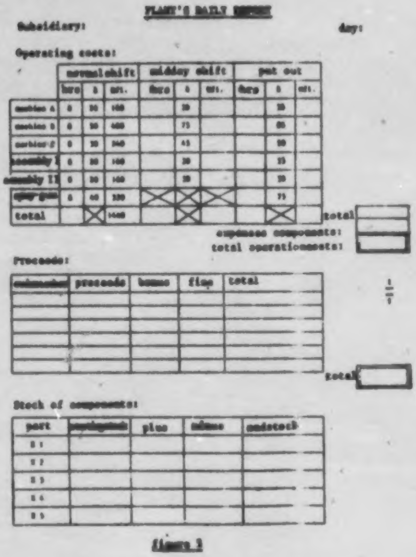


PLANNING-PRODUCTION FORM

Subsidiary .....
Day .....

Assembly I
Assembly II

Figure 4



PLANT'S DAILY REPORT

Subsidiary:
day:

Operating costs:

total
total operationcosts:

Proceeds:

total

Stock of components:

figure 5

The information provided to the team consists of:

- a daily survey of the worked hours of each subsidiary;
- a weekly financial survey of each subsidiary.

The offers are compared with each other by the central lead; they are then awarded to the lowest tenderer. Each subsidiary has the same machine equipment. All industries may therefore carry out the same orders, which are handed over to all at the same time (see figure 2, points 1 and 2).
By means of capacity planning a rough capacity demand and supply may be watched over.

Components can be obtained in three ways:

1. according to the fixed order sheet;
2. production by the subsidiary;
3. putting out to contract to the main factory.

You receive on day n+3

component	X1	X2	X3	X4	X5
number	a1	a2	a3	a4	a5

Information sheet concerning the components to be provided.

Figure 6

Essential in this simulation is good inventory control and to this end it is necessary that the subsidiaries design their own forms (see figure 2, point II). On the basis of an analysis of the information provided and of the data collected by the teams itself, it is possible, also with regard to the A-orders, to build up a purposive management in which, among other things, the following questions must be answered:

- for what application for an offer must tenders be made (capacity planning and inventory of components)?
- what time of delivery and price (costing calculation)?

Through estimating and costing an analysis of differences between computed and real costs can be drawn up.
The profit-and-loss account can be made up.
The routing of the forms as it has taken place during the simulation must be elaborated by the team in a compositive scheme (appendix 2).
The team leader has a complete survey of all orders at his diposal, so that he can check quickly for each day whether the orders have been processed properly.
The figures of costing and proceeds, together with stock changes are also checked by him.

The evaluation tasks and questions provided to the teams are:

- Specifying the allocation of tasks and the mutual communication.
- What was done with the information provided?
- What were the model of the capacity planning and the model of the inventory control like?
- What was the difference between the estimated and real costs of the A-orders?
- What was the strategy followed by the team in general and regarding the A-orders in particular?

4.2 The marketing simulation.

In this simulation each team is in charge of a washing machine industry. The production involves units of 20 machines. By investing in product development the product is improved and this may have a favourable influence on sales.

The industry has a basic capacity at its disposal which can be extended during the simulation (see 7).

When a fixed capacity is exceeded the factory building has to be extended. With too large a stock, stock costs have to be paid. The machines in this simulation are not written off. An information sheet concerning the fixed and variable processing costs with a given capacity, is provided.
The product can be sold in four districts. In each, thre are six wholesale dealers.
With the aid of salesmen, publicity, goodwill and telephone calls orders may be obtained. The salesmen must be trained by the industry itself.

By means of market research (including the purchase of information) it is possible to acquire data concerning the potential of the coming quarter or year.

On the basis of historical data sales prognoses can also be drawn up.
At the start of the simulation the teams receive the figures of the sales of the past 3 years and the prognosis of the coming year, in terms of per cent per district.
On account of the foregoing a sales strategy can be planned.
The forms used by the teams are:

- sales form to record the sale actions;
- quarterly survey to record the spending of the financial means;
- financial survey, in which are mentioned:
  - stock survey
  - debtor account
  - costs survey
  - cash survey
  - profit-and-loss account
  - balance.

As a start the years 0 and 1 are represented (see 7).

Additional remarks:

- A complete manufacturing costing price of 4,000 guilders is used during production. This costing price applies to a production capacity equal to the nominal capacity. In case of under-utilisation, the industry suffers an under-utilisation loss. If more than the nominal capacity is produced, an excess utilisation

profit is made.
- The production capacity may be extended according to the sales prognoses (range planning).
- Every year a bonus can be paid to the salesmen. If the bonus is too small, then there is a possibility of the salesmen resigning. Salesmen cannot be dismissed by the industry.
- Sales increase the debtor account, which is available after 1 year. Collecting in advance is possible, provided interest is paid.
- To benefit the financial planning a budget-sheet should be drawn up.

The team leader has an integral survey at his disposal, so that he can check quickly whether all the actions of the team are carried out in the right way.
Once a year, the following information about all teams is provided to each team:

- Number of units sold in the past year.
- Number of advertising pages.
- Total assets at the end of the past year and the profit/sales figure.

As appears from the above, the following aspects arise in this simulation:

- production planning;
- sales management/strategy;
- financial planning.

The teams are given the following evaluation tasks:

At the start: - describe the objectives of the industry;
- give the allocation of tasks;

- what are the sales expected in year 2?

After year 2:
- were the sales in year 2 in conformity with the prognosis? If not, why not?
- was the complete market potential sold in year 2?
- in what way was the expenditure, based on the sales prognosis, planned?
- what, in units, is the prognosis of the sales in year 3?
- what will be your market share in year 3?
- what does the rough financial planning look like on the ground of the above?

After year 3:
- how many units have to be sold at least in order to sustain no losses? (Draw up a break-even analysis).
- how much profit or loss is expected in year 5? And in year 6?
- how is the allocation of tasks at the moment and what analyses have been made?

4.3 The integral business simulation.

In this simulation the teams are placed in an integral business situation: from the purchase of raw materials up to and including the sale of the products in markets built up by them.

Each team constitutes the management of an industry of rubber footwear. The industries all manufacture the same six kinds of products.

Three kinds of raw materials, which can only be purchased at the beginning of the year, can at first be processed into finished articles on two kinds of machines. By joining in the development of a new machine, it is possible in course of time to obtain (by purchase) this improved machine, which manufactures all products in larger quantities. The machines are written off within ten quarters.
The extent of the production capacity can, as in the marketing simulation, be determined on the ground of the results and the prognoses of the sales.

Delivery of the goods is due two quarters after a sale is concluded at an industrial fair. This can be taken into account while planning (see 8).

The "phase-planning" has been built into the game to bring the long-term planning more to the front. The choice of the number of units of raw material per machine is made in such a way that it activates a long-term production planning with regard to the purchase of raw materials.
For example: For a production of 3,000 pairs of sandals and 4,000 pairs of slippers per quarter during one year, 304 units of raw material are needed. Then 400 units of raw material, which can only be ordered per 100 units, must be purchased.
Investments may be made in:

- machines (replacement, extension or renewal)
- buildings (extension of the existing building or a new building)

For the occupation of space of the buildings, which hold ten machines (all types) at most, an equivalency rule has been drawn up.

1 machine = 200 units of raw material = 10,000 pairs of products.

If this rule leads to an overstock, stock costs have to be paid.
The costing price has to be calculated by the team. In doing this, the fixed and variable parts of the costs must be stated.

The selling prices are determined also on this ground. The selling price must be determined twice during the first year and once at the beginning of the following years. All prices are made known to the teams.

The teams are free in their choice of fairs to be visited. For this purpose a schedule of fairs per quarter has been drawn up (see 8).
Price, salesmen, stand, publicity and goodwill determine the extent of the sale (in pairs) per article. A sales strategy has to be built up. At an "inter-industry" fair, to which one representative of each industry may be delegated, articles, raw materials and machines can be traded. Price and time of delivery are fixed on the spot (bargaining). The inter-industry fair is held under the chairmanship of one of the members of the central lead. This event has a very favourable influence on the communication between the teams and within each team. It is also an excellent occasion for interim discussions. The industry must thoroughly examine what information and what competence its representative is to be entrusted with.

At the start of the simulation no data about the market potentials are provided. Sales prognoses have to be based (especially at the beginning) on purchased information, combined with realistic considerations of the products and places where the fairs are situated. As a start, year 0 is played with the same starting data for each team (see 8).

The forms that are to be kept by the teams are:

- action form, on which the actions of the following quarter regarding planning and investments are mentioned;
- sales form of the following quarter: visits to fairs plus quantitative launch of sales instruments;
- cash-book and bank survey;
  Spending and source of the financial means, cash in hand, bank-balance and loan.
- profit-and-loss account;
- stock changing form
  - stock survey of raw materials
  - stock survey of products
  - stock costs
- balance sheet.

Additional remarks.

- It is possible to borrow money from the bank ro finance the expenditure up to 30 per cent of the total assets.
- "Direct-costing" is used as a method of costing-calculation.
  This method is far more surveyable and affords simpler office work with regard to the profit-and-loss account nd the balance sheet.

The stock of finished products is valuated on the balance sheet under the variable costs. In this way the profit-and-loss account and the balance sheet are in harmony with each other.

- In behalf of the financial planning an estimate has to be assessed involving:
  - purchase of raw material (once a year)
  - investments in buildings and machines
  - production costs
  - sales efforts.

This brings the necessity of mapping out a policy clearly to the front.

- An industry may drop the sale of some products and consequently offer a smaller assortment. But this has an unfavourable influence on the sales.
- Every year the following information is provided to each team:
  - the team's own capital at the end of the past year;
  - number of pairs sold (one figure) of the past year;
- The most important tasks which can be distinguished, are:
  - financial policy;
  - production planning and capacity;
  - sale plus sale and purchase at the inter-industry fair;
  - secondary tasks, e.g. filling in the forms, analysing the data, etc.

As in the preceding simulations, the team leader keeps a close eye on the team. During interim evaluations he discussed with them the tasks fulfilled and the strategy followed by the team, the decisions taken, and so on.

The following evaluation tasks are assigned to the teams:

Before the start:
- describing the objective of the industry
- allocation of tasks
- expected sales of each product in year 1
- stating all the selling prices

After year 1:
- the estimate of the following year and the decisions, taken on that ground, regarding production and sale

After year 2:
- cost allocation survey of the industry
- a break-even analysis
- the strategy followed by the industry regarding the inter-industry fair. What information does the team import to its representative?
- description of the strategy in general and concerning the sale in particular
- fixing the selling prices

End of the simulation:
- Report of the intercommunication. What was the eventual allocation of tasks? Did the assignment of tasks change during the simulation?
- Report on the information routing within the team.

What did the industry do with the information provided? What analyses were drawn up and has the team designed their own forms?

- Description of the strategy the team eventually followed
  - in general
  - regarding this sale
  - regarding the inter-industry fair
- What has become of the original objective?

Final remark.

The model was designed on the ground of data derived from a consultation between the designer and the manager of a wholesale house of shoes, boots, etc. So it can be called fairly true to reality. The numbers produced and sold today are much bigger.
The ratio of the figure (also concerning production) as found in the model is real.
This was found upon inquiry, when the model was repeated and corrected by three students [9]. Contrary to the computer version, the pattern of the markets can be changed easily (see chapter 6). Also, the market potential can be modified easily during or after the simulation (rise, fall).

5. Processing and evaluation of the data.

5.1 The planning simulation.

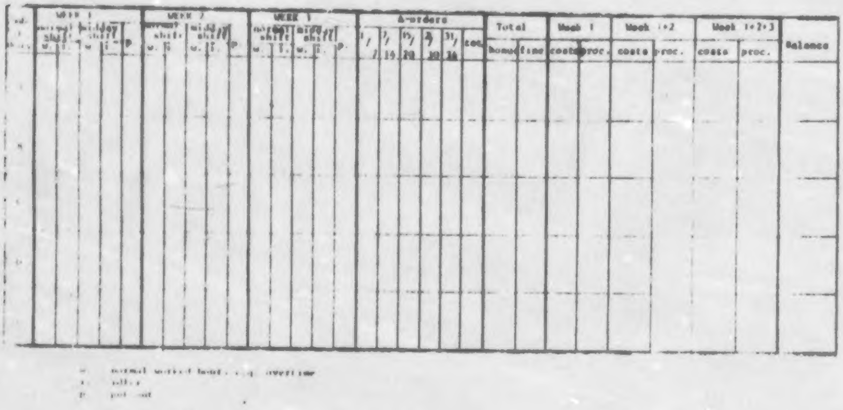
At the end of the simulation the team, in cooperation with the team leader, goes through the last questionnaire, and attention is especially drawn to the main

points of the policy followed and decisions. In the compositional scheme (appendix 2) the procedure followed is recorded and discussed. The group verifies whether the procedure in the simulated situation was satisfactory or not.
In a general final evaluation a report is made up on the basis of the same quesions.

During the simulation, the central lead collected and tabulated the data of the teams.
Figure 7 is an example of such a table. In it are mentioned:

- the number of worked hours per week in the daytime, overtime hours (afternoon work), and worked hours put out to contract;
- the number of awarded orders;
- the total amount of the bonus payments and imposed fines;
- the financial result.

The figures are compared with the maximum, averages and minima, scored until now in past simulations.



WEEK 1
WEEK 2
WEEK 3
A-orders
Total
bonus
fine
Week 1
Week 1+2
Week 1+2+3
costs
proc.
Balance

Figure 7

In the case of remarkable and outstanding figures the behaviour of the team is noted down in cooperation with the team leader.
This table is discussed with the teams during the general final evaluation.
An ideal case of the compositional scheme has been drawn up. This shows the routing of the forms and the allocation of tasks, as envisaged during the design of the simulation. The teams may compare their own scheme with it.
A model of the stock control is also dealt with.

5.2 The marketing simulation.

In the evaluations of the team with its teamleader the two following aspects are especially discussed:

- the strategy of the sales; are the sales as the team expected? What information was bought by the team or gained from analyses on which the prognoses were based?
  It is verified which markets were the most profitable. The "break-even" point is compared with the sales (expressed in units) and the production capacity so as to come to optimal attuning;
- the financial planning. How was the financial capacity used by the team? In the answer the estimate drawn up by the team, in which the expenditure with regard to sales instruments and the investments in extension and development are mentioned is involved. It is verified whether this estimate corresponds with reality and what caused differences, if any.

In this simulation, too the data of the teams are tabulated and are discussed with the teams in the general final evaluation. In the table are mentioned:

- publicity expenditure;
- costs of advice for purchased information;
- number of active agents and phone calls;
- interest payments;
- inventory costs;
- under-utilization loss and over-utilization profit.

As mentioned above, at the end of each year an information sheet is distributed, regarding the extent of the assets, the gross profit index (profit/sales), production capacity and number of units sold.

5.3 The integral business simulation.

After discussing the behaviour of the team with the team leader and going through the last questionnaire, these questions are again talked over in a general discussion. The teams report on the general course of things in their team during the simulation, the way in which the intercommunication and information flow proceeded, the way in which they took their decisions and the strategy followed.

The aspects mentioned above are given much attention especially in this simulation. An aid to this is the contact intensity diagram already mentioned (appendix 1), which may be significant in this simulation, because

- the teams are bigger (5 or 6 participants);
- the flow of information is more extensive.

The simulation is more wide-ranging because of, among other things, manufacture of 6 kinds of products, a far more differentiated production planning, purchase of raw materials, visits to the fairs and the inter-industries fair, the correct attuning of the several sectors of the industry to each other, a more extensive financial administration and the calculating and fixing of the costing and selling prices by the teams.

The central lead represents the following data of the industries in graphs and discussed then:

- the sales per quarter;
- the sales effected (cumulatively);
- the percentage of selling effort with respect to turnover;
- production capacity and investment spent on the new machine;
- the transactions at the "inter-industry" fair, in terms of money (cumulative).

Figures 8a-8d illustrate some examples. Figure 8c shows per quarter (in a histogram) which industries have purchased and sold. Afterwards (after the simulaiton) the market potential is compared with the quantity produced. In this consideration the "non-deliveries" are also taken into account. Starting from this consideration the market potential is corrected and adjusted each time.

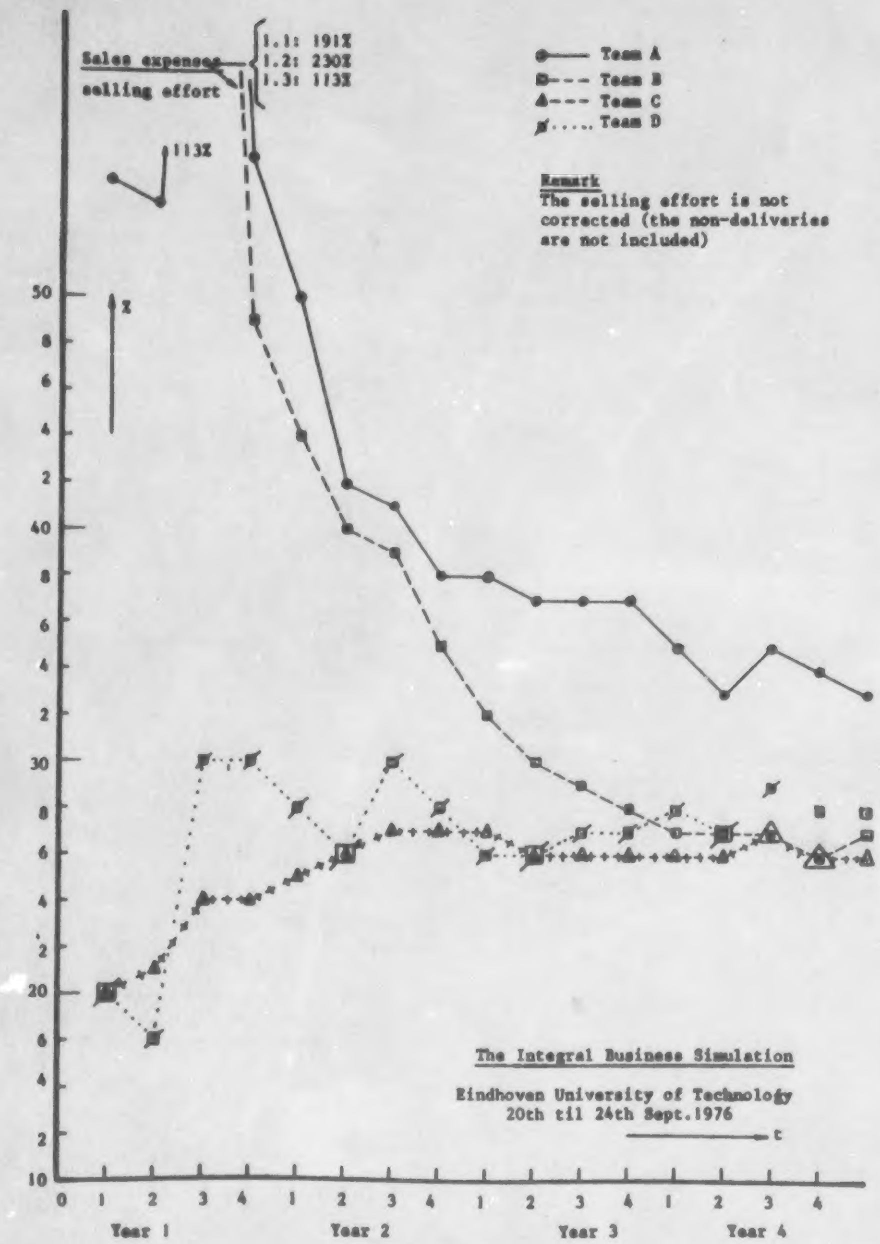
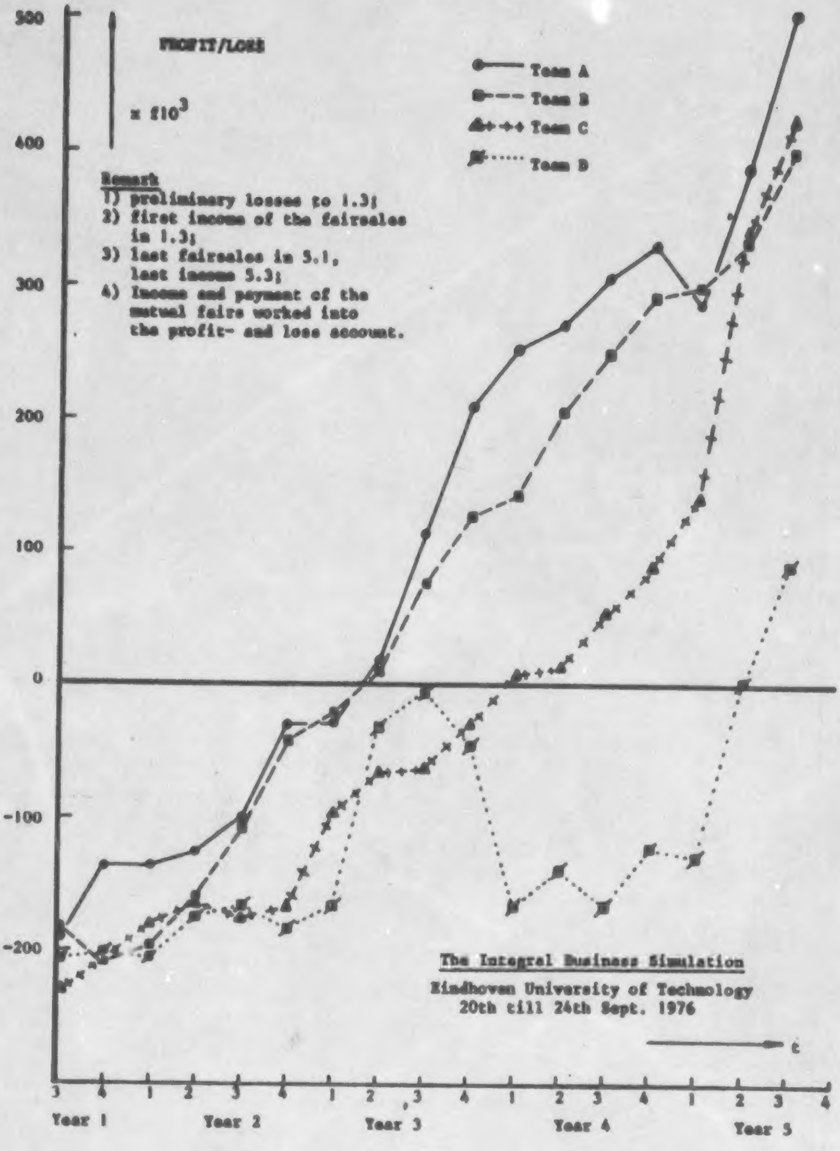

Sales expenses / selling effort
1.1: 191%
1.2: 230%
1.3: 113%
113%
%
Team A
Team B
Team C
Team D
Remark
The selling effort is not corrected (the non-deliveries are not included)
50
8
6
4
2
40
8
6
4
2
30
8
6
4
2
20
6
4
2
10
0
1
2
3
4
1
2
3
4
1
2
3
4
1
2
3
4
Year 1
Year 2
Year 3
Year 4
t
The Integral Business Simulation
Eindhoven University of Technology
20th til 24th Sept.1976

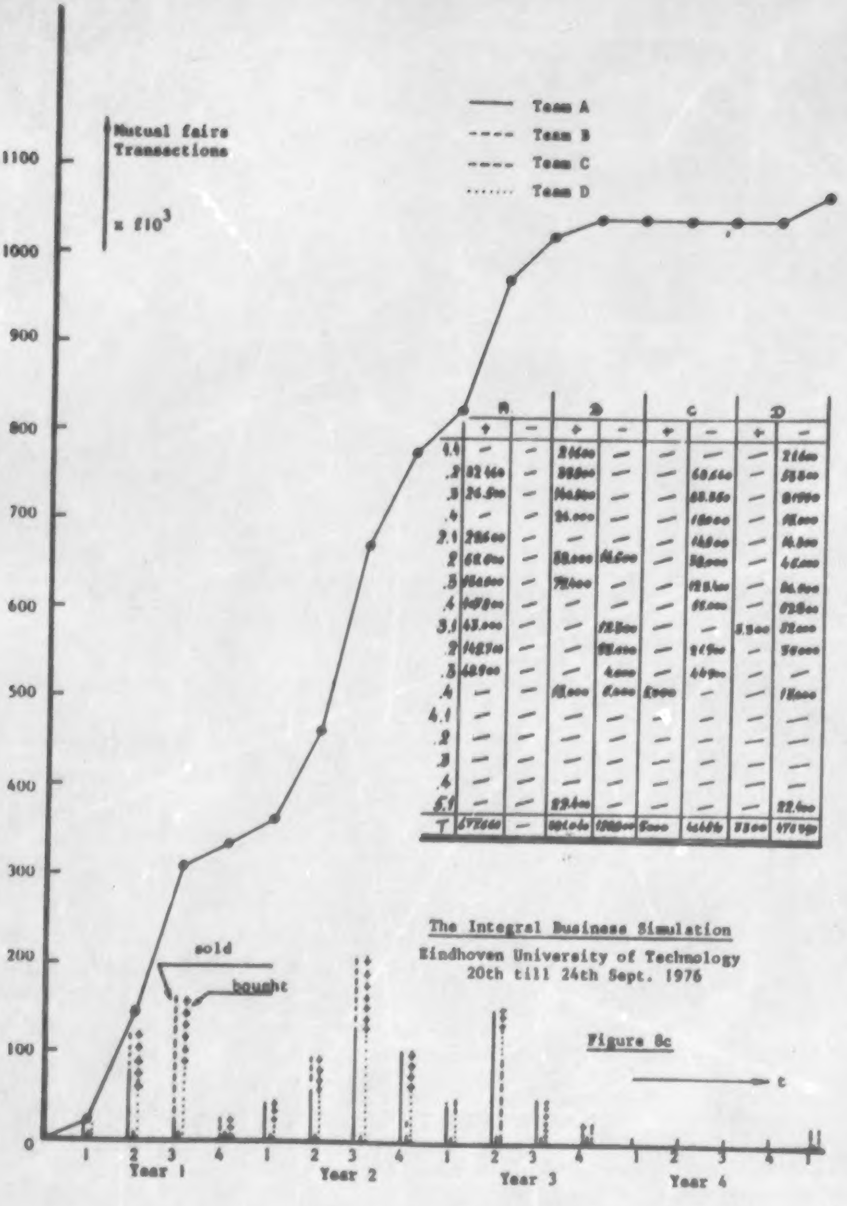
Figure 8a



Remark
1) preliminary losses to 1.3;
2) first income of the fairsales
in 1.3;
3) last fairsales in 5.1,
last income 5.3;
4) Income and payment of the
mutual fairs worked into
the profit- and loss account.

The Integral Business Simulation
Eindhoven University of Technology
20th till 24th Sept. 1976

Figure 8b

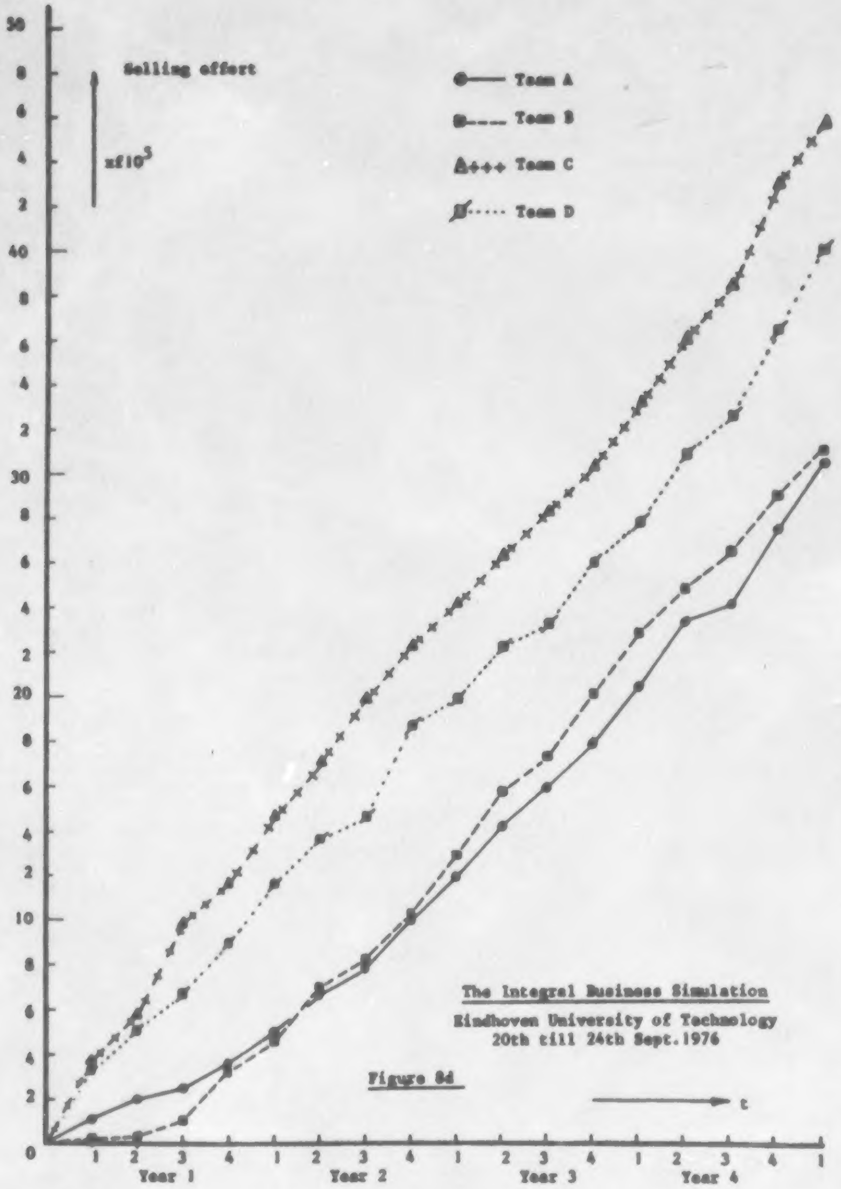


	A		B		C		D	
	+	−	+	−	+	−	+	−
1.1	—	—	216oo	—	—	—	—	216oo
.2	82.160	—	380oo	—	—	60.640	—	588oo
.3	26.500	—	160.800	—	—	88.850	—	81000
.4	—	—	24.000	—	—	18000	—	18.000
2.1	286oo	—	—	—	—	145oo	—	16.500
.2	62.000	—	88.000	16.600	—	50.000	—	46.000
.3	[illegible]	—	78.400	—	—	128.400	—	86.900
.4	[illegible]	—	—	—	—	95.000	—	[illegible]
3.1	43.000	—	—	12.500	—	—	5.300	32.000
.2	1427oo	—	—	98.000	—	219oo	—	54.000
.3	629oo	—	—	4.000	—	449oo	—	—
.4	—	—	18.000	6.000	5000	—	—	18.000
4.1	—	—	—	—	—	—	—	—
.2	—	—	—	—	—	—	—	—
.3	—	—	—	—	—	—	—	—
.4	—	—	—	—	—	—	—	—
5.1	—	—	22.4oo	—	—	—	—	22.4oo
T	[illegible]	—	[illegible]	[illegible]	5000	[illegible]	5300	[illegible]

The Integral Business Simulation

Eindhoven University of Technology
20th till 24th Sept. 1976

Figure 8c



The Integral Business Simulation

Eindhoven University of Technology
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Figure 8d

To sound the views of the participants regarding the integral business simulation, an inquiry was held three times.

This was done in three institutions, namely the Catholic University of Louvain, Department of Industrial Policy (January, 1975);
University of Agriculture of Wageningen, Department of Industrial Economy and Organization Theory (June, 1976);
and the Eindhoven University of Technology, Department of Mechanical Engineering (September, 1976); with a total of 58 participants.

Inquiry	Answer
1. In my opinion a long-term business policy is practicable 50 participants (86%) think it practicable.	Yes/no
2. I think the available data are..... 3. I think a(n) .... analysis can be drawn up from these data. 4. I think the learning effect with regard to a. costing calculation... b. planning............. c. finance.............. d. marketing............ e. teamwork.............	1. bad 2. insufficient 3. sufficient 4. good 5. excellent

Appreciation.

Question no.	2	3	4a	4b	4c	4d	4e
Average appreciation from 1 to 5 incl.	3,52	3,47	3,79	3,78	3,59	3,59	3,91

5. I think a working lecture should precede the simulation   Yes/no

   50% of the participants think a working lecture should precede the simulation.

40 students who participated in this inquiry, did not pass through the programme as sketched in chapter 2.

The participants of Wageningen and Louvain had had their own lectures on industrial economy and they only participated in the integral business simulation. The participants of the T.H.E. passed through the programme of lectures and simulations mentioned.
In general, the simulation has been appreciated positively. Here and there improvements have been introduced in accordance with suggestions which emerged from the answers of the participants;
they include:

- fixing the selling prices of the six products twice during the first year; correction is then possible. Incorrectly fixed prices may have too rigorous consequences on the sales of the industry concerning the first year, which may greatly injure the course of the simulation.

- having more direct assignments carried out enabling the participants to obtain more easily a better survey and analysis of costs or a break-even analysis.
- a correction of the market potential and the introduction of stock costs, so as to incite the teams to plan more accurately.
- course of lectures and simulations are better attuned.
- the time schedule is adapted.

6. The "hand-controlled" versus the "computer-controlled" simulation.

In 2 F. Meurs and J.M. Choffray find that the greater attainableness of the computer has been an important step in the design and the use of buniness simulation games. More complex mathematical models were used without worrying about the great amount of calculation work, and, consequently, much human effort. Thus the simulation would approach reality more closely. Therefore, it has been tried to build in more and more elements with the help of the computer. There is, however, the great danger of making the model far too complicated for the participants so that the model and the coherence between the various factors are no longer discernible. This may injure the learning effect and the motivation aimed at.

The computer model is a fixed and rigid model. Changes, not only during but also after the simulation, are difficult to realize. It loses much of the flexibility of the manually effected simulations and less scope is left for the creativity of the participants for developing their own tables and surveys from which to draw analyses.
The computer provides these now.

In 2 : "Exercise de gestion d'enterprise", developed by Dister, is mentioned as a good example. In behalf of the integral business simulation a computer programme has been drawn up 10 with which experience has been gained at the T.H.E.. A comparison between the computer version and the manual version was made and in the training course for mechanical engineers the manual version was chosen. It appears that

- the manual simulation does not require more all-in time than the computer version. Also, the time which is needed to elaborate the results after each round of decisions, is not longer;
- the danger of making the model too complex is not so great in the case of the manual version. Experience has shown (see 2) that simple simulation models have in essence the same learning effect as the more complex ones;
- a less complex model is more easily accessible to the student.

  On the basis of analysis it is easier to verify the coherence of the factors and to attune policy and prognosis;
- the manual version entails more work for the teams. This requires a closer and better described allocation of tasks, and good arrangements ought to be made with regard to the exchange of information, which causes higher demands to be made on teamwork;
- there is a more intensive contact with the team leader. This ensures good feed-back. There is more discussion and hence greater involvement;
- computer simulations are difficult to fit into the organization programme of a computer department (such as the computer-centre of hte T.H.E.);
- in case of failure of the computer the simulation cannot be continued.

On the other hand, the handplayed version requires more manpower than the computer version. The great amount of calculation is taken off the participants' hands by the computer.

7. Conclusions.

1. In our opinion, the simulations are very suitable to
   - acquire insight into
     - planning
     - pursuing a financial policy
     - the coherence of the different sectors and
     - functions of business.

   - import to the students some skill in
     - drawing up analyses
     - designing models, such as forms, tables and graphs.

   - learn to work as a team and to make decisions.

2. The programme is made up so that the students are first confronted with portions of business occurrences and later on with an integral industry.

3. Within the programme of mechanical engineering training, the hand-operated version is preferable to the computer version.

4. The simulations are positively appreciated by the participants (especially the integral business simulation).

Appendix 1.

The contact intensity diagram (see figure 9).

A contact intensity diagram is used to record the verbal contacts and their frequency between the members of a team. The diagram is discussed during the (interim) evaluations. It is verified why the team (or one or more members of it) does or does not function properly.

As mentioned in 4 , bad functioning of a team is often the result of shortcomings in human relations. This may vary from too many contacts in the non-business atmosphere to too few contacts in the business atmosphere.
Therefore, in the diagram it has to be expressed whether the contacts were relevant of not.

When a participant isolates himself, is isolated, or carries out irrelevant tasks, it is possible to discuss this with the help of the diagram.

Rather often, block-forming occurs within the team, e.g. planning-sales versus financial people. In the case of too little communication it appears that block one makes expenses for which there is no money, or that block two processes the wrong data.

The diagram is set up as follows:

- a room-plan is drawn
- the participants are indicated by circles in the position in which they are
- the following signs are used for the contacts:

: questions without answer

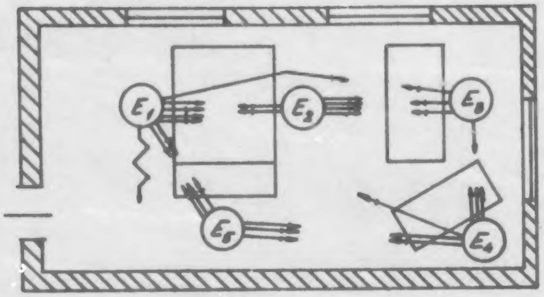
: questions with answer

: chattering remark

number of lines : frequency

The diagram is drawn up by the team leader in 10 minutes.

Example: Team E



Subjects discussed:
exposure time :
moment of exposure:

(person E5 carries out errand services)

Figure 9

Appendix 2.

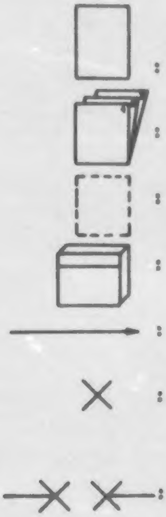
The compositional scheme (see figure 10).

To record an accountancy process, the routing of forms, a compositional scheme is used.

I 4 on page 22 it says:

"In small industries part of the information is passed orally, but during the growth of an industry, recording and providing of data in writing usually increases disproportionally.
This accountancy process, wich conducts and controls the technical process, must likewise be analysed at regular times".
For that reason the recording of this scheme has been introduced as an assignment.

List of symbols:



: form

: form in triplicate

: form already represented before

: department

: routing of a form

: preceding or further process not shown

: interrupted procedure, the interim procedure is not pursued.

⦶ : writing

⊖ : transport

○ : processing

⧀ : separating

◎ : junction

⊜ : checking

△ : temporary storage

⟁ : permanent storage (archives)

┆ : does not take part in the
process described

⟠ : is used for checking purposes

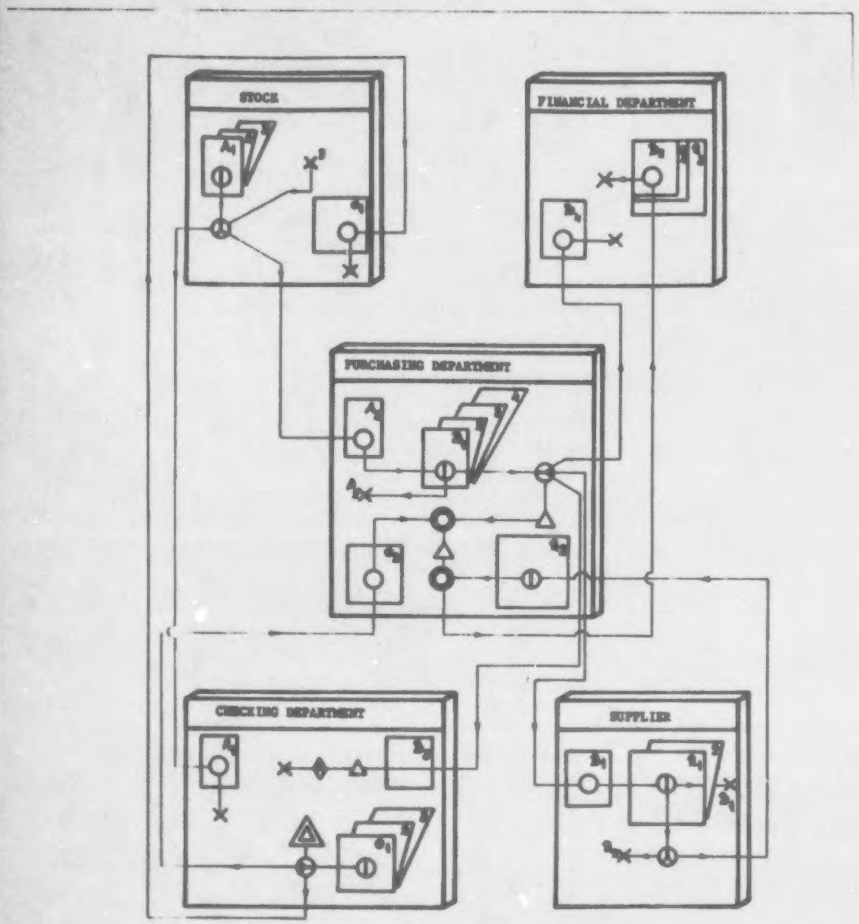
Example.

When the stock in a warehouse of an industry has gone down to a fixed minimum, the warehouse-keeper writes out an "application for order" in triplicate. He sends one copy to the purchasing department, one copy to the checking-department and one copy is kept by himself.

Purchasing department makes out an order-from in quadruplicate, the original of which is sent to the supplier, the second copy is kept by the department itself, the third is sent to the checking-department and the fourth to the financial department.

As soon as the goods are received, the checking-department, after checking quality and quantity, writes out a "receipt-sheet" in triplicate, of which one copy is sent to the warehouse together with the goods, the second copy to the purchasing department and the third to the industry's own archives. Purchasing department affixes the receipt-sheet to the order-form and files the two until the bill of the supplier arrives.

The bill is initialed by the purchasing department and together with the order-form plus receipt-sheet is sent to the financial department for further settlement.


STOCK
FINANCIAL DEPARTMENT
PURCHASING DEPARTMENT
CHECKING DEPARTMENT
SUPPLIER

A	application for order	O	receipt-sheet
B	order-form	R	Bill

Figure 10: The compositional scheme, an example

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Designing and programming a management game for industrial engineering.

1.0 Introduction

Since 1970 we have used at the Department of Industrial Engineering a computer management game with only eleven decision variables. Four of these variables were dependent on other variables, so that only seven really independent variables remained. The level of abstraction appeared to be too high; the relation with reality was lost. We played this game several times, but both students and staff members criticized this game too much.

During that time the need grew for a good management game for the Industrial Engineering curriculum. We selected after some searching, a so-called "integral management game" developed at the Mechanical Engineering Department (Balkestein, 1975). The materials of that game seemed to be very useful for Industrial Engineering. We had to redesign the game because our educational needs were rather different from the Mechanical Engineering Department's.

This paper will discuss the computerisation of the game and the adjustment to the goals of the Industrial Engineering Department.

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In the first stage we made a global plan for redesign. In the specification stage we met many problems. A preliminary version was quickly followed by the first version, which was supposed to be permanent. After a few try-outs we had again to improve the game. Most of the problems were caused by the way we wanted to use the game, and later by the behaviour of the system as perceived by the participants.

2.0 Global design

During the initial discussions about a new management game, it became clear that we were looking for a computerised game. We did not find a suitable game for our department, so we picked up the materials from an existing game which was conducted and computed by hand. This game, called "Rubber Schoeisel Spel" (= Rubber Footwear Game), is still used at the Mechanical Engineering Department. We used this game as a starting point for further development. The last activity in the first stage was the global redesign of the game, based upon the Industrial Engineering requirements. Only global decisions were made in this stage, such as for example the use of the Dutch language for better understanding.

2.1 Industrial Engineering requirements

We had some terrible experience with the total breakdown of a previous computer game, so we became very sensitive to the perfection of the model. The computer can only act as it is (mis)programmed, and the lack of flexibility is a well-known disadvantage of many computer programs. Another consequence of a computer game is the dependence on the organisation around the computer. Due to the good relations with our computing centre, we did not expect serious problems in this case.

The benefits of operating the game with a computer outweighed

the disadvantages. I mention here:
(1) The game can be supervised by one leader
(2) A refined model can deliver accurate results. The participants can spend their time making decisions instead of administrating. A high quality model makes gaming pleasant.
(3) Automatic check on the adherence to the rules of the game guarantees a fair play.

Especially the possibility of extensive and accurate results was the decisive factor for our decision to take a computer game. We discussed the possibilities of the existing hand game, and decided that it was not ready for use for Industrial Engineering. However, the essence and the outline seemed to be useful. The next section describes briefly the existing game.

2.2 The hand game

This game is a simulation of an oligopolistic market situation, where a few companies distribute their products. The companies take decisions each quarter of a year with respect to about forty decision variables on the management level. Each company can produce rubber footwear and sell it on the European market in seven trade exchanges. A distinctive feature of the game is that the companies can also trade with each other in mutual exchange.

In each game period, of about one hour representing a quarter of a year, four or five trade exchanges occur. A company can decide to visit an exchange with a certain stand size, number of salesmen, and quantity of advertising. There are six products, with a free price. The potential size of the market can be examined. Before delivery, the companies have to buy raw materials, and to plan production. Time lags are built in to put emphasis on planning. Uncertainty from outside must be reducted by plans inside the company.

2.3 Global redesign

We decided to build up a game ourselves, which gave us an opportunity to implement sufficient flexibility and perfection of the model. A new disadvantage was the time investment and the elapsed time for the whole project, but we had no choice.

Merging the industrial engineering requirements with the original materials seemed to be a simple matter of mixing. The influence on the technical part of the game was "only" noticeable at the specification level, and the organisational part seemed to be largely independent of the technical part. We were aware of the amount of details we had to consider, but we did not expect many problems in the specification stage. However, in the following section we describe what really happened when we tried to exploit the possibilities of the game.

3.0 Specification aspects

This section describes our problems in the specification stage, when we tried to exploit the possibilities of the game. The designing and programming process does not show a systematic approach, although we tried to streamline the process. The following problems are part of the development: some early difficulties in the preliminary stage, and some later difficulties in the transition to the first permanent version. I describe both kinds of difficulties as specification problems.

3.1 Disciplines

One can distinguish three main decision areas in this game, which are covered by three specialities of our department:

(1) Management Accounting and Marketing
(2) Operational Research and Information Handling
(3) Communication and Decision Making in groups.

We had the task to construct the model such that we could work in these areas at a suitable level.Criteria for suitability are the knowledge and skills of the participants before and after the game in the three decision areas. Both the model and the organisation had to take care of a pleasant game that might boost the motivation of the students.

ad.1 Management accounting and marketing are an indivisible part of the game, the first with an internal emphasis in the company and the second with an external emphasis. There are more than twenty decision variables in the marketing area. These are grouped as seven cities and six prices. Management accounting is a guard without direct decision variables. Our aim was to achieve a good balance between the marketing area and the other important items. We discovered that some emphasis on management accounting was widening the attention of the participants for other items, while emphasis on marketing limited the game to a marketing game.

ad.2 Operations research and information handling are implicitly present in the game. Although model building and some O.R.-techniques are a part of the curriculum, the world of OR is quite different in this game. There is doubt about the usefulness of the powerful techniques in this uncertain environment. The behaviour of customers and competitors must be guessed, while the financial room for manoeuvre is limited. Everything is continuously changing. The uncertainty is partly decreased by knowledge of the real world; the participants may use their knowledge and experience from reality. Our purpose is a better feeling for numbers and a better understanding of the use of simple OR-methods in these very uncertain situations under an inconvenient time-pressure. The need of a good information system is growing with time and a team which has not recognised this need, will be pushed down by their competitors. Especially the selection of output as a decision base for the participants was a difficult process. We decided finally to present many raw data, and to compute some results such as for instance inventory tables, but no key values for further analysis.

ad.3 Communication and decision making in groups. The game is inviting for items in this area. Four or five persons in a group have to divide their tasks. The presentation of the results demands this division. They have to complete one action form, and they have to send one representative to the mutual exchange. We discovered many ways of decision making and communication in the groups, and we coach the process in the group with some theories about decision making and facilities of communication. During a session we can make some time available for these activities, without disturbing the management activities. Participants are only interested in their group processes when the management process can be interrupted without damage to the decisions.

3.2 Modeling and tuning

The model accepts only quantitative decisions, so all the decision variables are numerical. We discussed the possibility of social variables, but we realised that the conversion to decision variables should again lead to quantitative decisions. Therefore we stayed with the two quantitative areas as mentioned before in the computing model, and the third area in the organisation of the game.

We tuned the model in such a way that we can emphasize all areas together. The game leader has a parameter set available, and this set gives him a considerable control on the progress of a game. For instance, the price sensitivity of the market or the line of credit for a company can be set from not important to very important. The parameter setting by default (if the leader does not specify otherwise) is a medium influence of all kinds of parameters. This can be the normal setting for a whole session. The leader is free in his choice of the parameter setting during the whole session, and in that way he can exercise a flexible control.

3.3 Computerisation

The initial requirements for computerisation were:

(1) Portability of the computer program, which means: the possibility to run it on different computers.

(2) Invisibility of the computer. The participants must have the feeling of a real company in a real market, they should not play against the model.

(3) Full error check on all decision variables and consequences.

ad.1 The program was written in standard FORTRAN. This language was the most suitable one with implemented input/output. The program handles all data sets internally without external files. That makes the program portable to any computer, but the amount of data in the program and the amount of output after the computations require a large computer system. The actual program uses about 200 Kb memory during 3 - 20 seconds (we made runs on Burroughs, DEC, and IBM machines), and it produces for each hour about 25 pages output. Memory and time and output are acceptable for quick usage on a large system.

ad.2 Although the participants know that the results are computed by a machine, they do not have to feel it. Their contacts with the computer are limited to the decision variables on the action form for input and the results on the computer output, so we can hardly say "contact". The leader can also reduce his contacts with the machine, but that is dependent on the organisation of the computer centre. If he wishes, he only deals with action forms, card deck and output.

During the first sessions we discovered that the participants had confidence in the financial results as computed by the machine, but they were very suspicious of the reality of the market model. After we told them more than once that we had constructed a refined model with "all" kinds of effects they became a little satisfied, but still with strong attention to unexpected events. This attitude is understandable because the market and the market model are the most uncertain parts of the management decision making process. However, the suspicion seemed to be greater with the use of a computer than with a hand game, and that is remarkable, because computerisation has greatly increased the realism of the market model.

ad.3 We made the model as fool-proof as possible against deviations from the rules, so the model cannot be blown up by the participants nor by the leader. We constructed error checking for the detection and simple correction of all errors. We spent many days on the many simple correction steps, because often we had to look for a reasonable alternative instead of a simple cut-off strategy.

3.4 Activities and time

We looked for a possible division of activities over the members of the group, so that every person could be active during a fair time, and also everyone could have some breaks. That is why we prescribe a number of 4 to 6 persons per group. The game does not prescribe the division of activities; the group is responsible for the allocation of tasks to persons.

The principal schedule is three quarters of an hour management time, and one quarter free time for activities such as a tea break or a discussion about the decision making process in the group. Management time is split up in two parts, because the mutual exchange, when one person is missing, interrupts the decision making process. The teams usually prepare the decisions before the mutual exchange, and they have sometimes to adjust them afterwards. A good task divison can provide a good progress, but that is a part of the learning process.

A complete game can be played as a block during three full days or spread for example in a couple of half days during two or three weeks. A longer playing time reduces the interest of the participants in the game. An advantage of the spread mode is that the teams have time available for analysing results or consulting a book between two sessions, and that less time is lost in case of a severe computer breakdown.

3.5 Input and output

The participants and the leader have their own manuals for the rules of the game. For the input in the model they use respectively the action form with decisions and the leader's form for other purposes. The output consists of leader's pages, and periodical results for each team with optional tables and graphs of selected variables. Especially the graphs are useful for the final meeting, when all participants are together for an evaluation of the game.

The action form (appendix 1) is completed by the participants.

RUBBER SCHOEISEL BEDRIJFSSPE

AKTIEFORMULIER

BEDR.	BEURZEN																					PRIJZEN						PRODUKTIE/ MACHINE-PLANNING												MACHINE BESTELLING			VERKOPER I.O. ONTW. MACH. Z en/of GEBOUW	INFO			TCKORTEN		INKOOP GRONDSTOF		
	UTR			LEE			FRA			BAR			ZAG			MOS			LEI			KL	DL	HO	DO	SA	SL	KL		DL		HO		DO		SA		SL						1e	2e	3e					
	S	V	R	S	V	R	S	V	R	S	V	R	S	V	R	S	V	R	S	V	R							X	Z	X	Z	X	Z	X	Z	Y	Z	Y	Z	X	Y	Z					S	P	A	B	C
01																																								4									3	1	2
02																																									2										
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S = STANDBEDRAG IN ƒ 1000,-
V = VERKOPERS AANTAL
R = REKLAMEBEDRAG IN ƒ 1000,-

PRIJZEN IN CENTEN,
BIJVOORBEELD ƒ 1,50 | |1|5|0|

Appendix 1
Action form

These data are punched on card right from this form. The meaning of the data is described in the participants manual, in accordance with the decision variables. Some variables are normally used with one significant digit with many following zeroes, so we introduced a scaling factor. We rescaled then the whole model, so that only one scaling factor remained. The purpose of this action was both to prevent scaling errors of the participants and to achieve that all variables of one decision period could be written on one line (one punched card per team). Most of the decision variables are written in one digit, some in two digits, and only the prices have four digits. Three digits are added to the line for input check by the computer, guaranteeing the proper order.

The leader's form (appendix 2) is optional, and filled in where necessary by the leader.

RUBBER SCHOEISEL BEDRIJFSSPEL **FORMULIER SPELLEIDING**

STUURKAART (numeriek)

AANT	ONTZ	GRAF	KO-L	TA-L	KO-T	TA-T	PRIN	PRIZ	PROD	VRRK	RENT	KRED	MCOR	PSYP	E-PR	E-VK	E-SR	HIST	D-ST
1 2 3 4	5 6 7 8	9 10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34 35 36	37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52	53 54 55 56	57 58 59 60	61 62 63 64	65 66 67 68	69 70 71 72	73 74 75 76	77 78 79 80

NAAMKAART (tekst)

NAAM VAN HET SPEL	BEDRIJF EEN	BEDRIJF TWEE	BEDRIJF DRIE	BEDRIJF VIER	BEDRIJF VIJF	BEDRIJF ZES
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

PARAMETERKAART (numeriek)

J	K	CODE	▨	GRAF	KO-L	TA-L	KO-T	TA-T	PRIN	PRIZ	OMST	VRRK	RENT	KRED	MCOR	PSYP	E-PR	E-VK	E-SR	HIST
		0 0 0	▨																	
1	2	3 4 5	6 7 8	9 10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34 35 36	37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52	53 54 55 56	57 58 59 60	61 62 63 64	65 66 67 68	69 70 71 72	73 74 75 76

ONDERLINGE TRANSAKTIES (CD in letters. overige velden numeriek)

J	K		VN	AANTAL	CD	KW	PRIJS	▨	VN	AANTAL	CD	KW	PRIJS	▨	VN	AANTAL	CD	KW	PRIJS	▨	VN	AANTAL	CD	KW	PR
		0						▨						▨						▨					
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MEDEDELING (tekst)

J	K	CODE	mededeling op één of twee kaarten
		0 9 9	
		0 9 9	

J= K=

Appendix 2.
Leader's form

He is the administrator for the decisions on the mutual exchange. He can write these decisions on his form in an easy prescribed format. These data are also punched on card right from the form together with the optional new parameter set and an optional message on the periodical output.

One of the first activities of the specification stage was the design of the output for the participants. We grouped data elements together in sets, such as a table with raw materials or the prices of the competitors' products. The presentation of information to the participants is very important. Both the presence and the lay-out of the data determine whether the user can find a figure quickly and interpret it in the proper way. Some figures are shown twice, for example: the total value of goods sold belongs to the table of sold products and also to the financial results. The density of information on a page depends on the amount of data for that page; the computer takes care of a smooth division of tables on the page. An error message is printed in a beam at the bottom of the page, that makes it conspicuous.

4.0 Improvements

After the preliminary version, we were very pleased with the first permanent version of the game, because running the game gave us no problems. But the pleasure was reduced by some other troubles. Although the model was almost perfect from our point of view, the participants criticized the model: they were not satisfied with some reactions of our "perfect" model. We had again to improve a number of parts of the model and the way of supervision, because discontented teams disturb the pleasure of gaming.

4.1 Realism of the model

The parameter settings and the formulae were chosen for an extremely wide range of decisions. But for instance the market model was continuously attacked by the participants. The difficulties were caused by their way of looking at the behaviour of the model as a function of only one variable apart from other influences, instead of all variables of all teams during the last time. Even a strong supervision could not take away their displeasure with the model. So we had the task to construct a model which should react "better than reality" and we succeeded more or less. The improved market model for instance balances between normal behaviour as an idealisation of reality and abnormal behaviour as a Sante Claus for the participants.

4.2 Error detection and correction

The program must be foolproof. Both participants and leaders make errors in a way we never could have foreseen. Many computer programs fail if the user fails, but that is not what we wanted to have. After a few sessions we could better protect the participants and leaders against their own mistakes, because we gained a better insight into the kind of mistakes and errors that users are prone to make. Since the program runs in batch, all errors must be corrected automatically, and that is not an easy task. In the first case the error messages have to be so clear that misunderstanding cannot happen. Important is the time required for recognising what is wrong and why it is an error. Participants expect an error correction which is so sophisticated that the correction gives a better decision that they could have invented themselves. Especially cases of complicated errors give rise to a never ending correction process. Often one error can be corrected in many different ways. From these we selected the most reasonable ones, and the model then calculates from these the most suitable correction.

4.3 Environment

What has been said about the model and the program is also valid for the manual; nothing should be open to misunderstanding. The reactions of the participants showed us where the descriptions were too compact. We tried to balance between a brief clearly structured description and a lawyer's document. Although the first is preferable we had to try to avoid the misunderstandings that did occur. Especially the terminology must suit the knowledge of the participants: not too simple and not too difficult.

Organisational improvements interfere with the program as a tool for the whole game. We discovered that emphasising one single component should happen with the greatest care, because the participants are paying so much attention to that component after the emphasis, that the remaining field is neglected. The tuning of the model was readjusted, so that paying attention to one subject involves other subjects as much as possible.

The time pressure must be handled in combination with the financial room for manoeuvre, which ties all decisions together. Too little room and/or too little time leads to gambling, while too much room and/or too much time leads to a slackening attention, which also causes gambling. The extremes must be avoided, but the optimum is hard to attain. Experience of the leader can guarantee a smooth progress of the game, and this also holds for the mutual exchange. The representatives can freely negotiate, but the time goes on and the leader must intervene when too much time is spent.

5.0 Conclusions

In this final section I shall repeat and sharpen some statements, as an introduction for a discussion about developing and using a management game.

(1) The only way to develop a useful management game is an integrating process, where designers and users cooperate in alternating activities.

(2) For a stimulating learning process the model must be better than reality, because it has to suit the overstrained expectations of the participants.

(3) The meaning of the decision variables and the results must be clear for the participants. Therefore the decision variables must be elementary, and the results must be presented in a simple well-structured way.

(4) The tuning of the model must be in balance with the purpose. The participants have to drift into some selected problematic situations, and the model has to cause that drifting, independent of the values of the decision variables.

(5) The environment of the participants must radiate the same effort as is expected from the participants. Both the leader and the model have to strain for a stimulating environment; enthusiasm is catching.

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Dutch	English
Handleiding	Manual
Schoeisel	Footwear
Bedrijfsspel	Management game
Deelnemers	Participants
Spelleiding	Game leaders

5.2.4 Drs W. J. J. Laseur and drs. R. H. C. van Oosten, School for Organization and Management (Interfakulteit Bedrijfskunde), University of Groningen, The Netherlands.

The management game at the School for Organization and Management (Interfaculteit Bedrijfskunde), University of Groningen, The Netherlands.

1. Educational objectives of a management game in the MBA-program.

The school for organisation and management of the university of Groningen offers a five year course leading to a degree of "bedrijfskunde drs.", which is equivalent to the MBA-degree in management. An overview of the course program is shown in Table I.

The students enter the course after successfully completing part I of studies in the Faculties Economics, Law, Behavioral Sciences, Science of Technology. Subsequently the "Interfakulteit Bedrijfskunde" offers a general course in parts II and III, leading to a BA-degree level (Kandidaatsexamen). During these two years the basics of organisational theory, economics, behavioral sciences, law and methodology are taught and an introduction is offered to the fields of finance, operations research, personnel management and marketing management. During this period the students experience a first perception of interrelationships between the various disciplines through the use of case-studies, special projects, a practical period and a management game.

The graduate program in parts IV and V is characterized by a multidisciplinary approach of organisational problems and some degree of specialisation.

According to its position in the course program a business game should provide an integration of the students' experiences in various courses offered in parts II and III and raise the applicability of course contents in a practical situation.
Besides it was recognized that gaming, as an excellent tool for inductive teaching (Becker, 1979) should allow for additional course objectives, like training in organisational capabilities. A variety of educational possibilities connected with gaming are summarised in Table II and described below.

- Players have to apply their basic knowledge of tools to control operations in finance and accounting, marketing, production and personnel management. The game aims at the development of skill in functional decision making.
- A perspection of the relationships between the various functions is stimulated. Participants should notice the differences in time-lags in the various operations.
- Organisational skill should be developed in the process of combining the functional decisions to a coherent and well aimed team performance.
- Team members will face the necessity of departmentalisation. Tasks should be allocated and coordinated, depending on the stage of the decision making process. Procedures should be designed and some discipline towards each other may appear a 'must' for cooperation, which is another kind of exercise in organisation.
- The cooperation within the team over an extended period of time should lead to interpersonal dynamics which

must be managed as far as these support or interfere with the functional decisionmaking and organisational processes.

- Finally the educational processes just mentioned should be largely stimulated by introducing in the game the judgement and advice of experienced managers, standing in the middle of today's business world.

TABLE I

SCHOOL FOR ORGANISATION AND MANAGEMENT, University of Groningen.

MBA-PROGRAM

(BEDRIJFSKUNDIG DOCTORANDUS)

PART I

IN A "MOTHER" FACULTY

ENTRY →

PART II AND III

- **BASICS OF "MOTHERDISCIPLINES"**
- **INTRODUCTION IN FUNCTIONAL DECISIONMAKING**
- **INTEGRATING ACTIVITIES INCLUDING MANAGEMENT GAME**

BA LEVEL →

PART IV AND V

- **MAIN COURSES AND OPTIONS**
- **WORKSHOP, INTERNSHIP, THESIS**

MBA LEVEL →

TABLE II EDUCATIONAL ELEMENTS IN THE MANAGEMENT GAME

FUNCTIONAL SKILL:

- THE USE OF TOOLS IN FINANCE AND ACCOUNTING, MARKETING, PRODUCTION MANAGEMENT, PERSONNEL MANAGEMENT.

INTEGRATIVE PERCEPTION:

- INTERRELATIONSHIPS IN FUNCTIONAL DECISIONMAKING

ORGANIZATIONAL EXPERIENCE:

- COMBINING FUNCTIONAL DECISIONS IN A PROCESS OF PLANNING AND CONTROL
- ALLOCATION OF TASKS } AS A FUNCTION OF THE STAGE OF
- COORDINATION OF TASKS } THE DECISIONMAKING PROCESS
- CONFLICTING DEPARTMENTAL INTERESTS
- COMMUNICATION, REPORTING

BEHAVIORAL TRAINING:

- INTERPERSONAL DYNAMICS IN RELATION TO DECISIONMAKING PROCESS

EXPOSURE TO BUSINESS ENVIRONMENT

2. The management decision laboratory.

Quite a number of business games are in use that provide an exercise in the application of management tools and include to some extent the interrelationships between the fields of finance, marketing and production management. Usually such games require a period of play of about one to seven days.
It was estimated that considerably more time should be needed for the development of cooperation patterns and interpersonal dynamics in the playing teams as indicated in the previous chapter. A management game of at least several weeks should be appropriate to these objectives.

The Graduate School of Business Administration of New York University (GBA-NYI) offers a complex man-machine game that includes most of the characteristics desired (Uretzky, 1973).
This game, at present called the Management Decision Laboratory (MDL), has been developed from the well-known Carnegie-Tech Game (Cohen, 1964). Since 1967 the MDL has been carried out at GBA twice a year, as a semester course. It is considered as one of the most attractive courses of the GBA-post graduate program.
The New York version of the game had to be condensed slightly to fit in the course program of the School for Organisation and Management at Groningen. Besides, adaptations of the game contents are desirable at its transfer from the New York business world to the Dutch environment. In close cooperation with GBA-NYU some of these adaptations have been realised so far and others are in process (chapter 4).

The Groningen version was played for the first time in Spring 1979 by 29 students (MDL-1979).

During twenty days of play, the students were organised into management teams representing four competing, medium-sized, publicly-held corporations. These corporations run the business over a simulated period of about fourteen months, The members of each group act as senior management, while the computer fulfills the roles of all the other employees, carries out the decisions of the management, evaluates the competitive interactions and prints results.
Features of the business world that cannot be duplicated in a computer simulation are introduced in the MDL-program by the participation of prominent businessmen and executives of public institutes, who bring their skills and experience to function in their real-life roles within the frame-work of the game.
To that purpose they are provided with only a brief orientation, regarding the nature of the company's operations and environment as well as their role in the simulation. During the first round in Groningen 14 external participants were involved. Eight of them formed the four Boards of Directors ("Raden van Commissarissen") together with an equal number of staff members of the School. The other external participants functioned as bankers, auditor ("accounant") and governmental representative. The enthusiasm in circles of managers to participate in the game-activities has been very encouraging. (After a while we were short of vacancies even, and had to put off about half the number of applicants for Board functions).

The management teams are responsible for the realisation of the business objectives, set by themselves, in the course of the game. The students are expected to carry out at least the following actions:

- To organize their own team.
- To analyse the results of the twelve months of their firm preceeding the moment that they were put in charge.
- To formulate business objectives, policy and strategy.
- To take the managerial decisions for each of the 14 simulated months.
- To prepare periodical reports and presentations for the four meetings with the Board of Directors.
- To negotiate with bankers and other external participants if appropriate.

3. MDL and course objectives.

The relations between the educational objectives (chapter I, Table II) and the MDL are illustrated in figure 1.
The many managerial decisions that have to be made are grouped in four functional areas: financial operations, accounting, production and marketing aspects.
The boundaries between the segments are not sharp: e.g. distribution may be assigned to production as well as to marketing the same holds for R and D. Besides, there is a lot of exchange and interaction between the areas as is obvious for pricing-policy and cost-accounting, finance and operations in the production or the marketing segment, etc.

In the light of the huge amount of work that has to be done in a short period of time (several hundreds of decisions per simulated month), the management teams cannot avoid a division of labor, an allocation of tasks, and an assignment of responsibilities.
Consequently the players should manage the problems of departmentalisation with regard to the efficiency and the optimalisation of decision making.

They will experience the naturally conflicting interests of the departments and the need for a coordinating structure and a decision-making procedure.
On top of it priorities should be set with regard to the relative importance of the various decisions. There is not much time available to analyse the facts and to calculate, estimate and forecast the effects of the alternatives on the overall performance of the company. Team members will find that only part of the actions can be discussed and that even fewer decisions can be made on the basis of concensus within the time available.
Obviously the management teams have to develop a strategy and a policy and to adhere to a chosen line of action.

The incentive to optimalize the quality and the consistency of the decision-making process by the game program itself and by the functioning of the external participants (figure 1). For our purpose constraints can be defined as conditions in the outer world of the company that must be fulfilled to ensure the continuity of the firm. Examples of constraints within the game program are the macroeconomical situation, the reaction of the market, tax regulations, the law and technical limitations. The external participants contribute to the sphere of constraints in their roles as bankers, shareholders, board of directors, union respresentatives and auditors to mention part of the possibilities.

Also the game administration adds to the constraints by introducing unforeseen coincidences and disturbances like shortage of raw materials, an energy crisis, etc. These events are communicated to the players by means of a monthly newspaper.

Last but not least the quality of the decision making process is a function of the interpersonal relationships that develop in the course of the game between the management team members.
A development that is strongly stimulated by the stress of time constraints and the necessity of frequent presentations of the team's performance to the external participants.

4. Adaptations of MDL to the Dutch environment.

The business environment in Groningen is very different from the New York situation. It appears to be desirable to adapt the way of financing and auditing, the market model and the aspect of industrial relations. Also the Dutch state support to industry and the possible government participation in individual companies has to be considered, not to speak of tax regulations and legal aspects.
Only part of the desirable alterations was realised before the start of the first student-round, called MDL-1979, in March 1979.
However, it was recognised that many of the environmental conditions would be introduced automatically by local external participants.

A sketch of the Groningen version is shown in figure 2. In the sphere or decision-making a sector for social management was added (chapter 5).

Some of the constraints were translated, others were added and need some explanation:

- The "CAO" that results from negotiations between employers and unions, is an agreement about wages and other working conditions in an industrial branch that is made or revised at fixed intervals. An "APO" is an agreement to maintain a fixed number of jobs over a period of time.
- General regulations of State support to industry can be built into the game program. The "WIR" is a tax reduction in connection with certain investments, "IPR" is a premium of the State paid to the establishment of new industries in economically weak districts.
- Regulations of State support to individual firms in financial problems can be simulated by the action of external participants.
  The NIB (Nationale Investerings Bank) provides loans under special terms; the NOM (Noordelijke Ontwikkelings Maatschappij) is a government-owned Company that participates in the risk-bearing financing of enterprises.

Apart from the adaptations of the contents there is also a difference in scale between the game in New York and in Groningen as is shown in table III.

TABLE III THE GRONINGEN VERSION IN COMPARISON WITH THE NEW YORK GAME

NEW YORK (FALL 1978)	GRONINGEN MDL-1979 (SPRING 1979)
96 STUDENTS IN 12 TEAMS	29 STUDENTS IN 4 TEAMS
4 COURSE MONTHS	2 COURSE MONTHS (20 GAME DAYS)
24 SIMULATED MONTHS	14 SIMULATED MONTHS
12 BOARDS OF DIRECTORS, EACH WITH 5 OR 6 EXTERNAL PARTICIPANTS	4 "RADEN VAN COMMISSARISSEN", EACH WITH 2 EXTERNAL PARTICIPANTS AND 2 STAFFMEMBERS
5 BOARD MEETINGS	4 BOARD MEETINGS
45 OTHER EXTERNAL PARTICIPANTS	6 OTHER EXTERNAL PARTICIPANTS
STAFF INVOLVED:	STAFF INVOLVED:
5 SENIOR TEACHING STAFF	1 STAFF (TEACHING AND RESEARCH)
6 TEACHING ASSISTENTS	2 TEACHING STAFF PART-TIME
4 SENIOR RESEARCH STAFF	5 STAFF IN ADVISORY COMMITTEE
1 RESEARCH ASSISTENTS	8 STAFF IN "RADEN VAN COMMISSARISSEN

5. Social management.

In the New York version personnel occurs in two sections of the decision-making sphere of figure 1: in production and in marketing.

The production department has at its disposal four categories of workers with regard to their degree of skill. The personnel manager is responsible for the optimalisation of the labor mix by means of new-hires, lay-offs, promotions and training. Labor productivity and costs of labor are functions of the labor-mix and consequently functional interrelationships result between production, accounting and personnel management. Besides, the costs of labor are related to the level of wages and benefits resulting form negotations of the personnel manager with the Unions.

In the marketing department the only personnel decisions to be made refer to the number of salesment and the allocation of them to sales districts and products. No interfunctional relation exists between personnel management and commercial results.

The New York personnel model does not fit well in the Dutch framework. Next to the quantitative personnel decisions of the New York model a number of qualitative aspects of social management should be included with regard to working conditions like the nature of recruitment, introduction, training, promotion career planning, work satisfaction, work democracy and benefits.

Besides, the qualitative aspects should be related clearly to the overall results of the company.

As an experiment in the direction of more complete social management a set of additional game rules was introduced in MDL-2979. According to the new rules, the manager in charge produced a social report every simulated month, that consisted of an analysis of the foregoing period, together with guidelines, objectives and decisions about the social policy in the next period. The social report was assessed by the lecturer personnel management. This assessment was used by the game administration to change labor productivity, absenteeism and labor turnover of the firm accordingly.

In this way the qualitative aspects influenced production figures to some extent, similarly to the effect of the quantitative decisions in the New York version.
Finally, it should be noticed that the actions of the Dutch personnel manager in the game were restricted compared with his American colleague with regard to lay-offs and new hires, according to the Dutch legal limitations.

The results with this social management model and further improvements are dealt with in the next chapters 6 and 7.

6. Evaluation of MDL-1979.

Not surprisingly, the first student round of the MDL in Groningen has not been technically flawless. The main executional problem originated from the fact that only one staff member was available full-time for the double task of instruction of players and administration of the game. Results should have been better with three or at least two fully engaged staff members.
Fortunately the game itself raised such a level of enthusiasm of players and staff members that - generally speaking - the technical frustrations could be overcome.
Apart from the commitment of external participants the running of the game requires a considerable effort from the side of the staff of the school (see Table III). The question should be answered how far the outcome of the first round justifies the effort. It is easy to put the question, but difficult to answer it. How to measure the students' progress in capability to deal with a complicated organisational assignment in teamwork?
Some comments can be given, based on observations during the play by the game administration and reactions of players, staff and external participants. First the development of skill in functional decision making will be

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considered.

Initially the financial management appeared to be difficult; however, the students soon learned to cope with it. With regard to accounting a shortage in basic techniques and in understanding of cost-accounting indicated shortcomings in the foregoing course program.
It appeared to be possible to deal with the commercial management in the game with available knowledge. However, students were not able to optimally use the offered possibilities of market research and forecasting. Players commented that in the games production management they learned the hard way that down-to-earth accuracy and systematic work are at least as important as sophistication.
The new rules in social management appeared to be an improvement of the quality of this aspect in the game.
However, the assessment of monthly social reports by teaching staff with a somewhat artifical link to company's performance by administrators' changes of labor productivity absenteeism and labor turnover showed the desired educational effects only partly.
In particular the interactions and the relationships of social management with the other functional decision-making areas were vague and inconsistent as yet. As a consequence the personnel managers got a somewhat isolated position in the management teams.

To the opinion of the majority of players and others involved the organisational experiences of the students were valuable and rather unique with regard to the duration and intensity of the exercise.
It is interesting to observe how communication patterns and decision-making procedures changed and developed over the lifetime of the teams.

Each team developed an identity, strongly different from the others. Two teams began with a colleague-like decision-making structure, but soon recognized the usefulness of distinct hierarchic levels. Two other teams started with an hierarchic structure to discover how difficult the role of a general manager might be. Also it was found that the team with the highest academic average will not be the best per se; the team with the smoothest organisation can make a better overall result. Perseverance is another key factor to success in the game. Another fruitful experience was the observation that strongly opposing characters may jeopardize the team's performance and that in such cases job rotation might help to some extent.

The institution of Boards of Directors was particularly useful in contributing to the spirit of the game and to the educational results of the exercise. In their realistic and practical attitude and from a pragmatic view on management the Directors guided the student teams in the course of the game gradually to a businesslike approach. With sometimes hard critism, the Directors commented on organisational structure and operations of their management team, checked strategy and policy, evaluated results and insisted on clear and concise presentations in reports an explanations of the participants at the Board meetings, which were held four times in the course of the game. The other external participants contributed to the success of the game in the same sense.

The students put a lot of effort in MDL-1979. Many of the players worked very hard and spent a lot of overtime to improve their company's results. It could be expected that some of them insisted on an assessment in terms of a mark. For several reasons marking was not done:

- there are no reliable yardsticks to evaluate the individual's performance separately from the team's performance;
- the interpersonal dynamics in the team may be disturbed easily by a marking procedures;
- the functions of the players are not equal in nature and weight.

In MDL-1979 there were no evident cases of dropouts in the sense of students taking it easy and leaving the work to their colleagues in the team.

The performance of a team could be assessed by observation of the quality of the decisions made, the cooperation within the team in its daily operations and at the occasions of the team's presentations to the Board of Directors or its negotiations with other external participants.
Though in most cases quantitative game results like market share and profit figures were found to be in line with the observations just mentioned, these indications were considered with reserve.
Rather then aiming at the highest profit figure at the end of the simulated business period the team should struggle for the realisation of the total set of objectives made up by the team at the start.

7. Improvements of the simulation game.

From the experiences in the first student round we came to the conclusion that some improvements can be made in the next round (MDL-1980). See also table IV in connection with table III.

TABLE IV PLANNING OF THE NEXT ROUND

GRONINGEN MDL-1980

45 STUDENTS IN 6 TEAMS

4 COURSE MONTHS (20 game days)

14 SIMULATED MONTHS

6 "RADEN VAN COMMISSARISSEN, EACH
WITH 3 EXTERNAL PARTICIPANTS AND
1 OR 2 STAFFMEMBERS

4 BOARD MEETINGS

9 OTHER EXTERNAL PARTICIPANTS

STAFF REQUIRED:

200 MANDAYS (E.G.: 140 DAYS TEACHING STAFF
60 DAYS TEACHING ASSISTENTS)

GAME DEVELOPMENT 1979/1980:

110 DAYS RESEARCH STAFF

160 DAYS RESEARCH ASSISTANT

- Lecturers in charge of the functional decision subjects should anticipate on the game as often as possible in their courses.
  The same holds for the lecturers in organisational and behavioral sciences. Besides the latter will often refer to game experiences afterwards. A full integration of the game in the course program should provide a strong support of the various course contents.
- Teams should be made up and informed about the educational objectives of the game in an early stage.
- The accompaniment of the lecturers during the game is essential.
  Besides, a simulation expert should be available for technical advice to the teams, apart from the game administration.
- A committee of students who participated in MDL-1979 is advising about the implementation of further operational improvements.
- The function of social management in the game will be improved basically. The computer program itself should include interrelationships between social management and the other functional decision making areas. Besides, the social management sector needs "life" negotiations, not only with the Board of Directors, but also with representatives of the employees, the Labor Unions and the government. For these aspects the circle of external participants should be enlarged.

8. Conclusions.

- A large business game half-way through the MBA-program of the School for Organisation and Management is considered to be a fruitful teaching instrument with regard to a number of course objectives that are not easily realized by other educational methods.

Our first experiences with a slightly condensed and adapted version of the Management Decision Laboratory (MDL) of the Graduate School of Business Administration of New York University are clearly positive.

- Players confirmed that they gained new views at the interrelationships between the various faculty courses and that they increased their capability of applying the material of these courses.
- The training of the players to manage the problems of a complex organisational assignment in team work probably is an even more important aspect of the game.
- In particular the interactions of the students with high-level executives from outside contributed to the success of the course.
- Some adaptations of the New York management game to Dutch circumstances have been realised so far. Further adaptations are in process. The MDL appears to be highly flexible in this regard, probably because of the use of external participants.
- The staff requirements of the exercise should not be underestimated. In the next round of the game a staff-load of 200 man-days will be needed to realise the game for a class of 45 students (Table IV).
- The size of the game in its present form (20 game-days in a period of 4 months) is probably critical. In a shorter game the interactions within the teams and between teams and external participants might not develop to a satisfactory extent.
- In our department some small research capacity is available for further development of the game (Tabel IV). Work will be done to improve the social management aspect. Organisational and behavioral aspects will be optimalised. In the future work will be done on the program structure.

A new database will be developed in relation to a modular construction of the MDL. The resulting modernised game could possibly be split into independent modules that might be useful for specialised courses in our faculty and in other management schools. Also the modular version may be used as a heuristic device (Uretzky, 1973; Becker, 1979).

The Management Decision Laboratory may be not only a teaching laboratory but also a research laboratory in which human decision-making could be evaluated under controlled circumstances.

MDL - NEW YORK VERSION

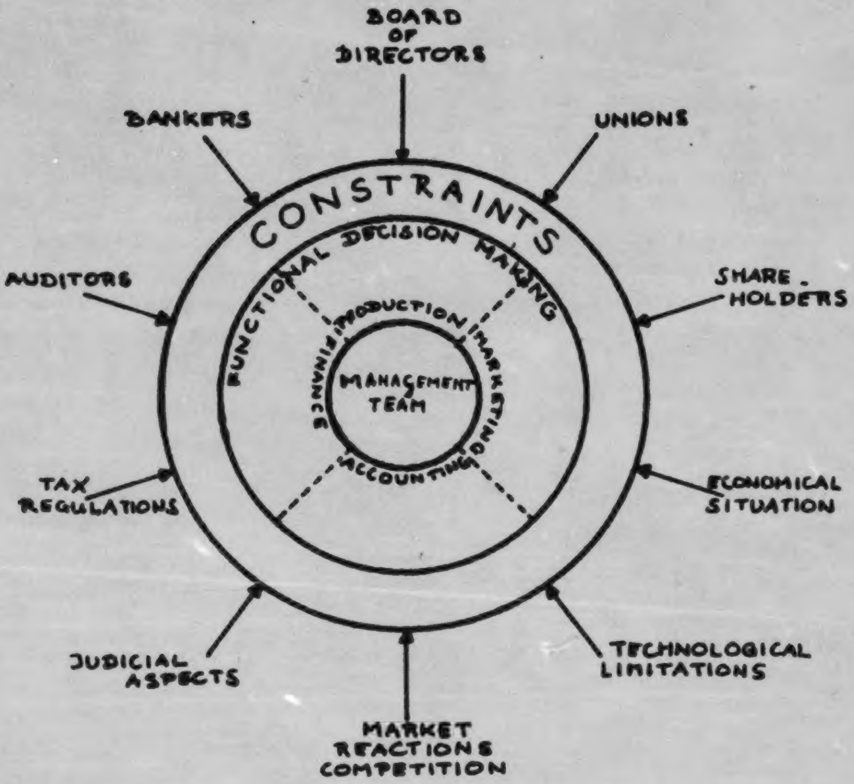
BOARD OF DIRECTORS
UNIONS
SHARE-HOLDERS
ECONOMICAL SITUATION
TECHNOLOGICAL LIMITATIONS
MARKET REACTIONS COMPETITION
JUDICIAL ASPECTS
TAX REGULATIONS
AUDITORS
BANKERS
CONSTRAINTS
FUNCTIONAL DECISION MAKING
PRODUCTION
MARKETING
ACCOUNTING
FINANCE
MANAGEMENT TEAM

FIG. 1

MDL-1979 (GRONINGEN VERSION)

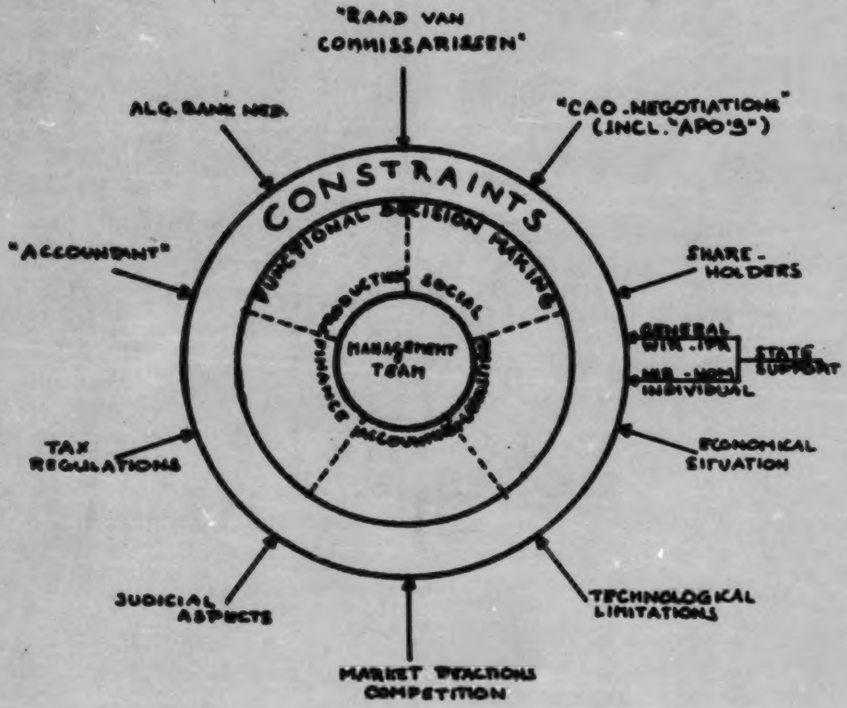
"RAAD VAN COMMISSARISSEN"
"CAO.NEGOTIATIONS" (INCL. "APO'S")
ALG. BANK NED.
"ACCOUNTANT"
SHARE-HOLDERS
GENERAL WIR.-IPR
MR.-NOM INDIVIDUAL
STATE SUPPORT
ECONOMICAL SITUATION
TAX REGULATIONS
JUDICIAL ASPECTS
TECHNOLOGICAL LIMITATIONS
MARKET REACTIONS COMPETITION
CONSTRAINTS
FUNCTIONAL DECISION MAKING
PRODUCTION
SOCIAL
FINANCE
ACCOUNTING
MANAGEMENT TEAM

FIG. 2

TABLE I

SCHOOL FOR ORGANISATION AND MANAGEMENT, University of Groningen.

MBA-PROGRAM

(BEDRIJFSKUNDIG DOCTORANDUS)

PART I

IN A "MOTHER" FACULTY

ENTRY

PARTS II AND III

- BASICS OF "MOTHERDISCIPLINES"
- INTRODUCTION IN FUNCTIONAL DECISION-MAKING
- INTEGRATING ACTIVITIES INCLUDING MANAGEMENT GAME

BA LEVEL

PARTS IV AND V

- MAIN COURSES AND OPTIONS
- WORKSHOP, INTERNSHIP, THESIS

MBA LEVEL

TABLE II EDUCATIONAL ELEMENTS IN THE MANAGEMENT GAME

FUNCTIONAL SKILL:

- THE USE OF TOOLS IN FINANCE AND ACCOUNTING, MARKETING, PRODUCTION MANAGEMENT, PERSONNEL MANAGEMENT.

INTEGRATIVE PERCEPTION:

- INTERRELATIONSHIPS IN FUNCTIONAL DECISION-MAKING

ORGANIZATIONAL EXPERIENCE:

- COMBINING FUNCTIONAL DECISIONS IN A PROCESS OF PLANNING AND CONTROL
- ALLOCATION OF TASKS AS A FUNCTION OF THE STAGE OF
- COORDINATION OF TASKS THE DECISIONMAKING PROCESS
- CONFLICTING DEPARTMENTAL INTERESTS
- COMMUNICATION, REPORTING

BEHAVIORAL TRAINING:

- INTERPERSONAL DYNAMICS IN RELATION TO DECISION-MAKING PROCESS

EXPOSURE TO BUSINESS ENVIRONMENT

TABLE III THE GRONINGEN VERSION IN COMPARISON WITH THE NEW YORK GAME.

NEW YORK (FALL 1978)	GRONINGEN MDL-1979 (SPRING 1979)
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24 SIMULATED MONTHS	14 SIMULATED MONTHS
12 BOARDS OF DIRECTORS, EACH WITH 5 OR 6 EXTERNAL PARTICIPANTS	4 "RADEN VAN COMMISSARISSEN", EACH WITH 2 EXTERNAL PARTICIPANTS AND 2 STAFF MEMBERS
5 BOARD MEETINGS	4 BOARD MEETINGS
45 OTHER EXTERNAL PARTICIPANTS	6 OTHER EXTERNAL PARTICIPANTS
STAFF INVOLVED:	STAFF INVOLVED:
5 SENIOR TEACHING STAFF	1 STAFF (TEACHING AND RESEARCH)
6 TEACHING ASSISTANTS	2 TEACHING STAFF PART-TIME
4 SENIOR RESEARCH STAFF	5 STAFF IN ADVISORY COMMITTEE
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TABLE IV PLANNING OF THE NEXT ROUND

GRONINGEN MDL-1980

45 STUDENTS IN 6 TEAMS
4 COURSE MONTHS (20 GAME DAYS)
14 SIMULATED MONTHS
6 "RADEN VAN COMMISSARISSEN", EACH WITH 3 EXTERNAL PARTICIPANTS AND 1 OR 2 STAFF MEMBERS
4 BOARD MEETINGS
9 OTHER EXTERNAL PARTICIPANTS

STAFF REQUIRED

200 MAN-DAYS (E.G.: 140 DAYS TEACHING STAFF
60 DAYS TEACHING ASSISTANTS)

GAME DEVELOPMENT 1979/1980:

110 DAYS RESEARCH STAFF
160 DAYS RESEARCH ASSISTANT

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5.2.5 Ir. C. J. Vriesman, Policy analysis Department, Delta Department (System Management Division), Rijkswaterstaat, Den Haag, The Netherlands.

Decision making for controlling a stormsurge-barrier.

1.1 Introduction.

This paper will deal with the problems the management of a construction firm has to deal with in making their decisions in order to acquire contracts on a bidding market. We will also talk about the building industry and the use of the management-game "ASA", which is specially designed for teaching students and others the problems the management of a construction firm will meet on a bidding market.

If one looks at the main activities of a construction firm, one can say that there are 3 groups:

1. activities to get work;
2. activities to carry out the work;
3. activities to coordinate the items 1 and/or 2 in such a way that the goals can be realized.

In this presentation we will only tackle the first and third groups of activities.

The presentation can be divided into 6 parts:

A. the general philosophy;
B. the continuing price-determination;
C. the present state of the research in question;
D. the decision making areas of a contractor and some preliminary results of our research;
E. the developing of the ASA-management game;
F. a look at the future.

2.1 The general philosophy.

In general the emphasis of this research (partly presented here) lies, as said before, on decision making of the individual contractor in order to obtain contracts on a bidding market. This implies that:

First, one has tried to get insight into the most important questions that have to be answered by the contractor to stay in business;
second, models are built to help solve the problem the contractor meets when answering these questions.

The intention is that the uncertainties and risks be reduced by using decision-making models, which show à priori the consequences of the various alternatives.

Next, we will explain in detail that the researchers felt and still feel the need to give the contractors (= construction firms) after this research not only a guide in which the models are explained, but also something more substantial. That was one of the reasons to build an ASA-game, which provides the contractors with an instrument to test their experiences.

3.1 The continuing price-determination.

There are a number of possibilities for a contractor to obtain a contract. These are:

a. a public tender (all contractors may bid);
b. a private tender (pre-selected contractors are invited to bid).

The public tender is mainly used by governmental departments.
In most circumstances of the bidding process, the winning bid is that bid that seems most attractive to the principal (generally the lowest bid). For a couple of years the criterium of allocation (lowest bid) and also some aspects of the public tender system have been amply discussed in periodicals, such as ASCE/ENR/Building/Cobouw/Financieel Dagblad and so on.

In the Netherlands a governmental committee has been set up, which has been instructed to study the bidding system. This committee submitted recently (2 years ago) a report containing various recommendations. Up till now nothing has materialized on that issue.

4.1 The present state of affairs in the research in question at Delft University.

As said before, the research of models containing critical questions to a contractor can be formulated as:

"to do scientific research which is so useful in practice that it can be implemented".

Considering the general aim, we realised that:

a. it was/is not possible to provide an analytical solution of the problem at short notice;
b. it is difficult to fill the gap which exists between practitioners and researchers to analytically view and implement the results of the scientific research;
c. there is a lack of true, readily available data.

This leads to the conclusion that research should be done with the aid of simulation-models.

Research knows 2 components:

1. a theoretical component;
2. a practical component.

In the theoretical component there are two models BIDSIM I and II. The former gives bidding-results, the latter corporate results.

In this respect we should also mention that a management game ASA has been developed. This game gives students and other people the opportunity to tackle "reality" without "real consequences".
The practical component is the study we have done on the spot. By participating in a big construction firm, we were in a position to:

a. see how decision making takes place in these fields;
b. test some strategies, which have come up from BIDSIM I and II and which look promising.

In this presentation we shall leave the practical study aside, and give you a more detailed explanation about the models BIDSIM I and II and ASA.

5.1 The decision-making areas of a contractor.

The main problems in creating simulation models and/or games are:

1. selecting the key-mechanism of the reality you want to describe;
2. validating that mechanism.

First, we will go into the selection problem.
To select the "keys" we follow certain ways:

1. we read existing relevant literature;
2. we invite practitioners, in writing or personally, to state the main issues concerning this topic;
3. we check whether the answers are derived form their own experience or from literature.

These activities have led to distinguish four areas of decision-making, which are so relevant that they should be incorporated in a simulation model.
These areas are:

1. acquisition;
2. to bid or not to bid;
3. cost estimating;
4. price determination.

It appears in practice that for the decision-making in the four areas four different strategies are needed.
In the following we will try to explain one by one the areas involved.

5.3 The acquisition-area.

The question in this area is:

"In perspective of the firm's goals, what are the possibilities of the firm on the bidding market and (to what degree) should those possibilities be employed?"

This question is an essential one on a strategic level for the management of a construction firm. It is very hard to answer this question because of its rather high abstract nature and also because the bidding market is not a static, but a dynamic one. Up till now, none of the models we have built incorporates the complete acquisition-problem. In the future, when revising the models, we should consider incorporating this factor.

5.4 To bid or not to bid.

The second area is of a more tactical nature. This area still has to be further explored. The essential question here is:

"On what project, the contractor is invited to bid for (public: always/ preselected: sometimes), shall I bid or shall I not?"

The answer to this question depends on two parametres:

1. nature of the contract;
2. nature of the enterprise itself.

One can divide a project into factors like capacity-utilization, financial contribution, owner, and so on.

You can define the company-status by statements like workload now and in the future, financial status, and so on.
In the models we built we have the opportunity to take into account decision-making rules for this area. Several policies are developed for it. Some give the expected results, some do not.

5.5 Cost estimating.

At the tactical level of management decision-making of a firm that desires to obtain contracts is also included the area of estimating costs and planning the work to be carried out.
The critical question in this area is:

"What costs should be spent on estimating the costs and planning the project the contractor would have to carry out?"

This means that the assumption that a contractor can manipulate the accuracy of estimating the costs holds true. Graphically we can illustrate it as follows:

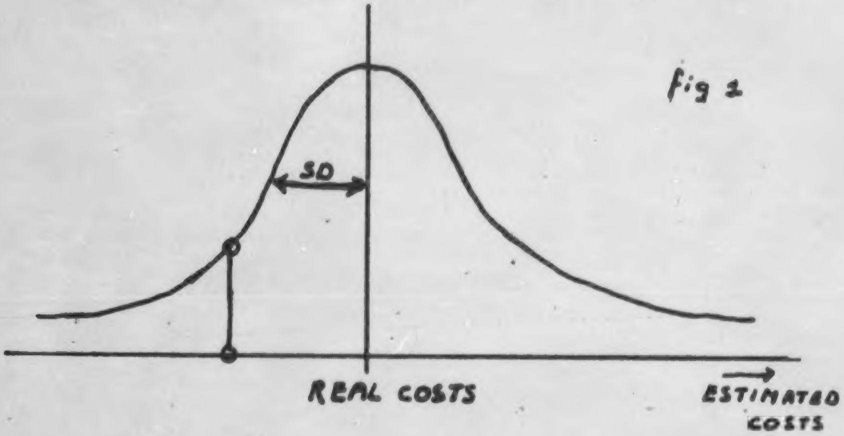


fig 1

By enlarging this effort in estimating he can influence the standard deviation. In practice we found that there exists such a type of relationship. Usually, the SD, not from a normal curve, but a betadistribution, lies between 5-10% of the real costs.
The policy the contractor employs for this area, apart from the relation it has with other areas, is rather relevant from the viewpoint of allocating the job to the lowest bidder.

Suppose one participates in a public bidding and one is bidding for work. If one is the only one, one realizes one is with several others, no one realizes the profit desired. We call this phenomenon the allocation-effect. This allocation-effect depends on the number of competitors bidding for work at the same time.

5.6 Price determination.

The last area we shall mention is the price-determination-area. For this area models of a highly sophisticated mathematical level to rule of thumbs policies, are developed. The question for this area is:

"How high should the profit margin be (added to the estimated costs)?"

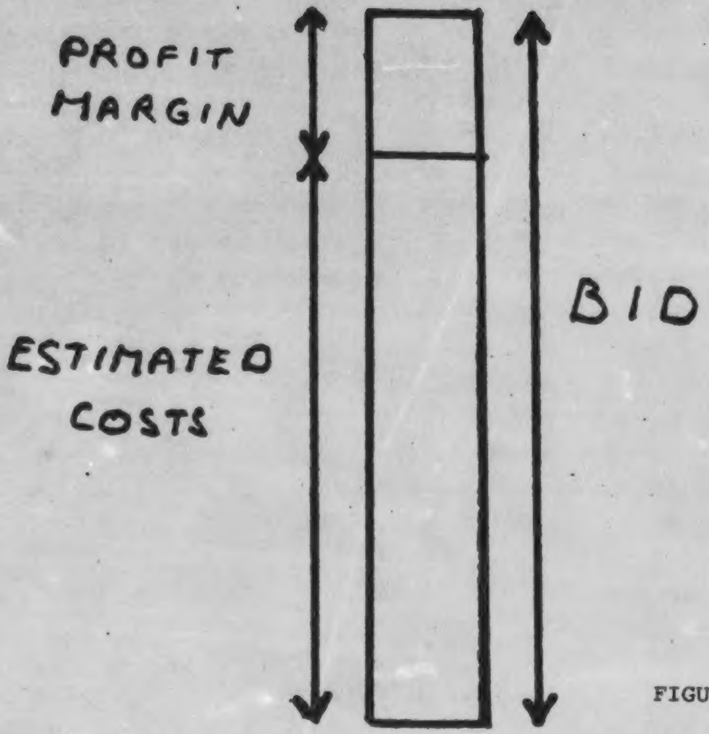


FIGURE 2

It is very easy to see that an answer to this question is essential.
If the profit margin is high, the contractor does not get the contract, because his price is too high. If the profit margin is too low, the probability of getting the contract increases highly, but also heightens the chances of losing money on the contract owing to the stochastic character of estimating the real costs.

In our model we have developed and tested some other models. Some look promising and these we have also tried out in the field. Others do not give what most contractors want: both work and profit.
Here ends the explanation of the four areas of decision making.

5.7 In the beginning of the explanation of the areas we said that after selecting the key-mechanism it is also important to select them in such a way that they can be validated. In our research we have done so to a certain extent.

Up to this point, my presentation was oriented towards our research to build the simulation models. But, as said before, this was not the only aim of our research. What we wanted, and we repeat it for you in brief, is to look at:

1. decision making to acquire the contract;
2. decision making to carry out projects;
3. coordinating these two items in an efficient way and to train people in this field.

One way of doing it is to do it on the job, but

a. it is very complicated to find out why some results appear and others do not;
b. it is also a very risky situation in terms of costs.

Therefore, we created the management game "ASA" to give people the opportunity:

I. to get insight into the key mechanism of running a construction desiring to acquire contracts;
II. to learn to make decisions under uncertainty in the field concerned at individual and/or group level;
III. to realize that decision-making by means of "simulation" models is the right thing to do.

The management game is "only" a game, which means that the participants alone or as a group simulate the

management of a construction firm.
The number of teams that operate is practically limited. This means that about 5 to 15 contractors should be in the game.
All the contractors who participate in the game have to make decisions ("monthly") in the described 4 areas. So there will be a market, which may be manipulated "monthly" by the game-master.
The contractors are asked for formulate:

a. the objective they want to research in a certain period of "playing" time;
b. the instruments they want to use to help them reach their goals.

That means that a policy should be made for each of the four areas separately or in combination. The principal may also try out some strategies, although the game is not really set up for that purpose.
Up till now, the game has been played five times publicly.
Some preliminary conclusions can be drawn:

a. Does the game reach its goals?
   In a certain way: Yes. We found this out by asking the people to fill in questionnaires before and after playing the game.
b. for the game itself
   some mechanisms are critizised especially by practitioners.
   This leads to a re-designing of the game.

As an overall conclusion we can say that even in the first version the game has proved to be a good instrument to teach people the main aspects of decision-making in the construction industry to obtain contracts.

6.1 A look at the future.

From the research on this project we conclude that:

1. Via simulation models BIDSIM I and II students, scientists, practitioners may get insight into the problem of decision-making.
   This can lead for practitioners to make up their minds about the policies to be used, but also about the use of the bidding-system in the future.
2. The game "ASA" is a delightful instrument to teach people at universities and so on "real life" situations without consequences. It is also a good instrument to initiate discussions about the bidding system.

Anyway, both issues of this research have shown that in future it is possible to make a plan in close collaboration with the researchers on the bidding system itself.

5.2.6 Ir. C. J. Vriesman and Mr. J. van der Spek, Policy Analysis Department, Delta Department (System Management Division), Rijkswaterstaat, The Hague, The Netherlands.

Decision making for controlling a stormsurge-barrier.

1.0 Introduction.

The Netherlands, as indicated by its name, consists of low areas of land, many of which even are below sealevel. (see figure 1.). This means that about 40 to 50% of the Netherlands population lives and works on a level below the water surface of the sea. As a consequences, from the beginning the first inhabitants populating and tilling the soil had to protect themselves against the danger of the water. Looking at the Prinvince of Friesland, for example, one will see that (in the old times) already 'terpen' (local name for embankments) acting as dams, were built.

Until the late thirties dikes were considered to be sufficiently high to protect the hind-lying land if the highest known storm-surge-level could not reach over the dike. Only in 1939 did Wemelsfelder prove the relation between the probability of a certain water level of a storm-surge and the occurence of same in the time.

As a result of the Second World War little attention was given to this latest knowledge. One went no further than drawing a few conclusions as regards to the existing si-

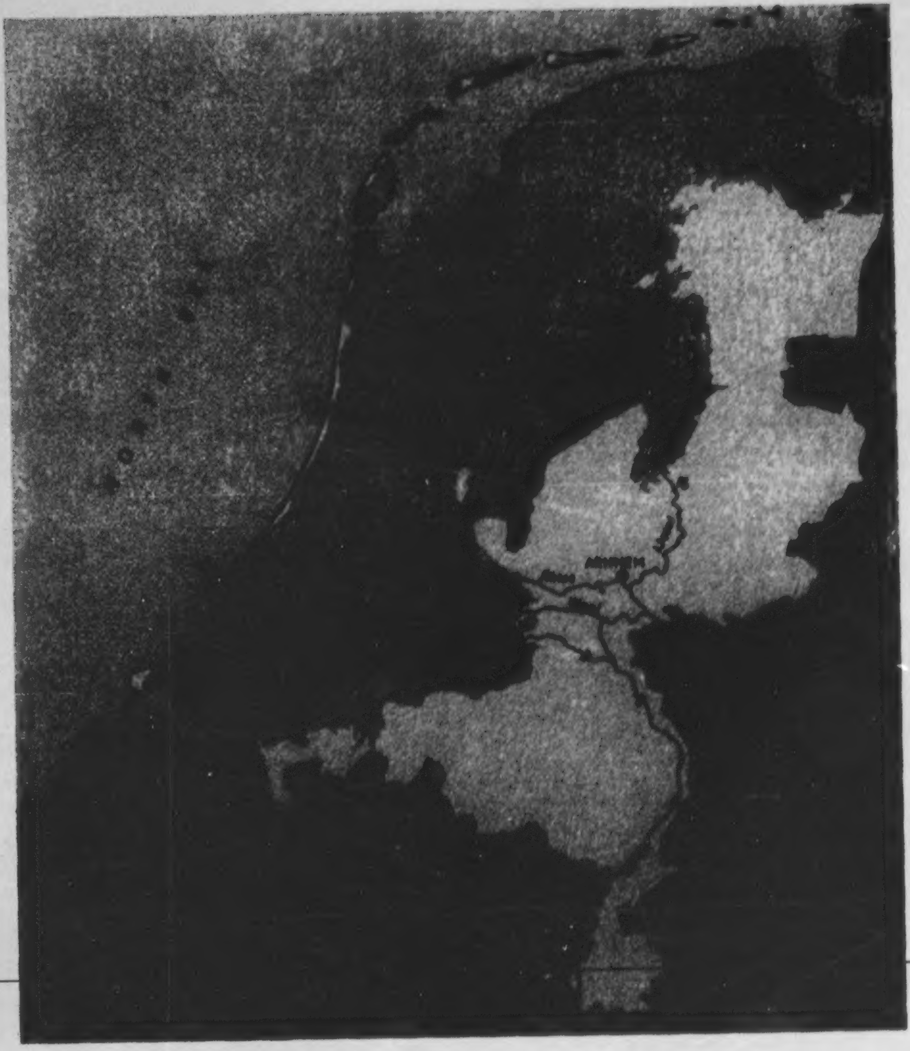


figure 1.

tuation of the Dutch dikes; all these conclusions were still in an embryonic stage, when on February 2nd of 1953 during a storm a disaster took place. Because of the flood water level of 3.85 meter the dikes and dams collapsed in many places in the Delta area. As many as 1835 people were killed during this disaster, 72,000 people lost goods and chattels and about 150,000 hectares of land were flooded. About 190 kilometres of dikes were either levelled or heavily damaged (see figure 2).

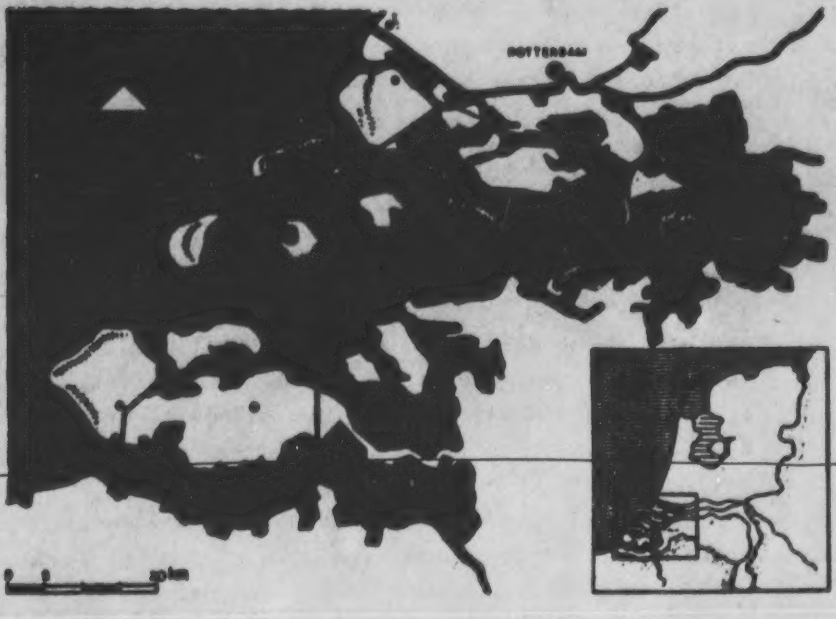


figure 2.

As a result of this storm the project regarding the protection and safety of the South-West Netherlands and originally started by the "Stormflood Committee", was taken in hand by the so-called "Delta Committee". Immediately after the flood-disaster an emergency act was introduced called "the Emergency Act for Dike-repair". The Delta Committee worked energetically. After various interim advices the Committee recommended that, instead of heightening the dikes, the sea-arms in the Delta area be closed. At the same time it emphasized the need to legalize the realization of its designed project, the so-called Delta plan.

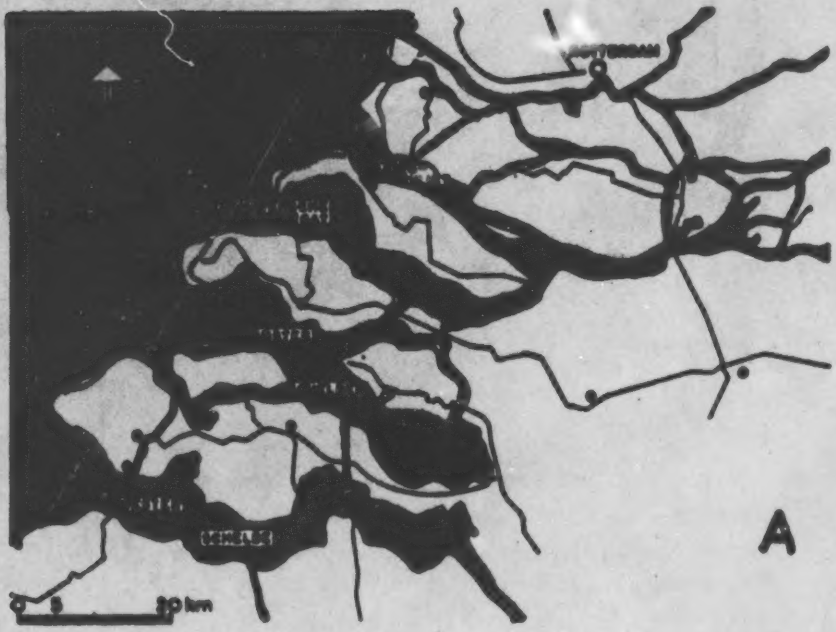
On November 16th 1955 the "Act on the closure of the estuaries between the Westernscheldt and the Rotterdam Waterway and the strenghtening of high water dams in order to protect the land against storm floods" was introduced.

In 1957 and 1958 this bill was passed in both Houses of the Dutch parliament. Prior to the acceptance of the bill the execution of the so-called Delta-plan was already started (see figure 3).

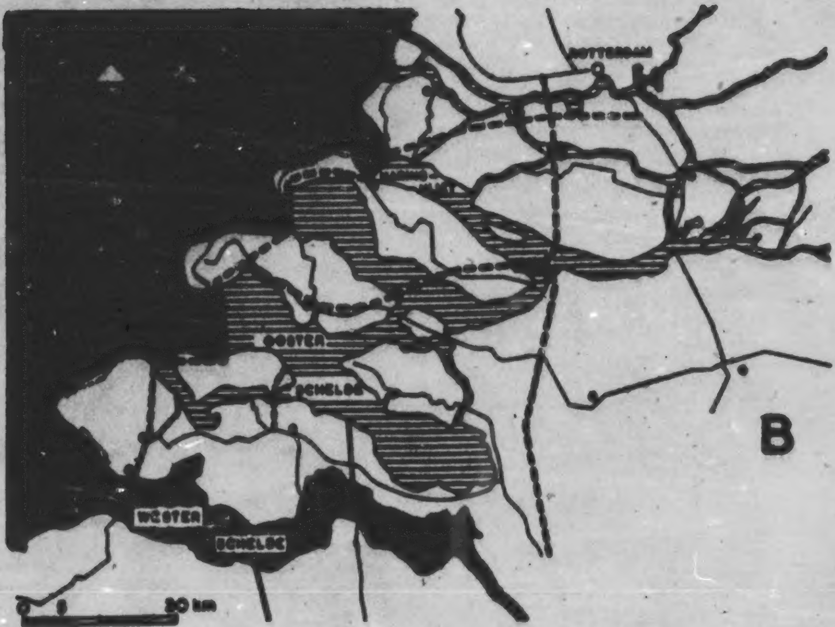
In order to be able to hold the realization of a plan of such special character in one hand, the Minister of Public Works and Waterways set up a special branch of Rijkswaterstaat, called the Delta Service, on May 1st. 1956.
Since the mid-fifties the Delta Service has been and still is closely collaborating with various divisions of Rijkswaterstaat, such as "Sluices and Weirs" and "Bridges". Together they have succeeded in expediently executing the Delta plan. In the adjacent figure 3B the Delta plan is illustrated, whereas a reproduction of the original situation in the Delta area is shown in A, thus

clearly indicating what had to be changed and what has been changed already by the execution of the Delta plan.

figure 3.



In drawing B the shaded part indicates which fresh water basins will be created after the execution of the plan. You can also see that after the realization of the plan the coast will be considerably shortened. At the time when the plan was legalized, the costs of the sketched Delta plan were estimated to be 2.5 milliard (Am. billion) guilders.



The money was to be spent in a consecutive way based on the priciple to realize the plan "from small to large" objects. This principle was grafted on the idea that knowledge and experience would grow step by step with the increasing complexity of the tasks already performed, thus leading to a better planning and realization of the works.

It is clear that the closure of the Easternscheldt, which has been programmed as the last but also the largest job, requires a special knowledge and experience.

When the time arrived that a start had to be made with the Easternscheldt-part of the Delta plan, it seemed that indeed all necessary "know-how" was available to achieve closure. However, it soon became apparent that all this know-how offered no quarantee that the original Delta plan could be implemented.

During a special congress in 1967, various aspects concerning the closure of the Easternscheldt were discussed in public. In subsequent discussions not only the advantages, but also the disadvantages of the closure were more and more emphasized. One of the most important arguments against the closure of the Easternscheldt, as designed in the Delta plan, was that the effects on the envirionment, fisheries, and so on had not sufficiently been taken into consideration.
It was said that closure of the Easternscheldt would cause:

- destruction of the biologically rich ecosystem in the Easternscheldt without any guarantee that this would be replaced by another ecosystem of the same high order.
- destruction of one of the last large nature areas as regards to both the aquatic and the shoal areas.
- disappearance of the nursety function (for shrimps and various species of fish) in the Easternscheldt.
- the end of the mussel and oyster cultures.
- the diminution of possibilities for water-recreation.

Many lengthy discussions have been held about an open or a closed Easternscheldt. Finally another committee was set up on August 15th 1973, the so-called Committee Easternscheldt (popularly known as the Committee Klaasensz, named after the Chairman of the Committee). On March 1st 1974 this committee gave its advice to the Minister of Publich Works. In this advice the committee recommended, in the first instance, the construction of a (temporary) perforated dam across the mouth of the Easternscheldt, whereas in the second instance, a storm-

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surge-barrier should be built, which would be situated further inland. The solution as presented by the Committee would cost 1,5 milliard guilders more than the original plan.

In an advice to the Minister regarding the proposals of the Easternscheldt Committee, the Advisory Board for Waterways recommended a change in the suggestions. The Board insisted that a caisson dam be built in the first phase. Again after ample discussions the Den Uyl administration decided on July 12th 1974 to study whether the proposed caisson-dam could also serve as a permanent dam, thus avoiding the construction of a storm-surge-barrier at a later date.

On November 9th 1974 a final decision was taken by the Cabinet. A caisson-dam with a movable water retaining structure may be built across the mouth of the Easternscheldt provided that:

a. the Rijkswaterstaat can prove that the plan is technically feasible;
b. the additional cost will not amount to more than 1.6 to 1.7 milliard guilders.

The Cabinet's proposal was accepted by Parliament on November 19th and 20th, but only on the following conditions:

1. The plan has to be technically feasible. Within 18 months proof thereof will have to be submitted.
2. The plan must not exceed the estimated cost of the closure in the original plan by more than 2 milliard guilders.
3. The plan should be completed by 1985.

On June 17th 1976 the Minister, Mr. Westerterp, informs the Second Chamber in writing that the government has taken a positive decision to close the Easternscheldt by means of a storm-surge-barrier. This decision is based on the final report submitted by Rijkswaterstaat which states that studies have shown that the Delta Plan is technically feasible.

More than a year later the definitive wet cross-section of 14,000 m^2 was decided upon. With this aperture size a main tidal difference of 2.70 metres with Yerseke occurs (this means 77% of the tidal difference when there is no barrier). A number of groups still doubt whether this cross-section is big enough and there are still people who desire a larger cross-section (of 20,000 m^2).
On the adjacent figure 4 the design of the storm-surge-barrier is reproduced.

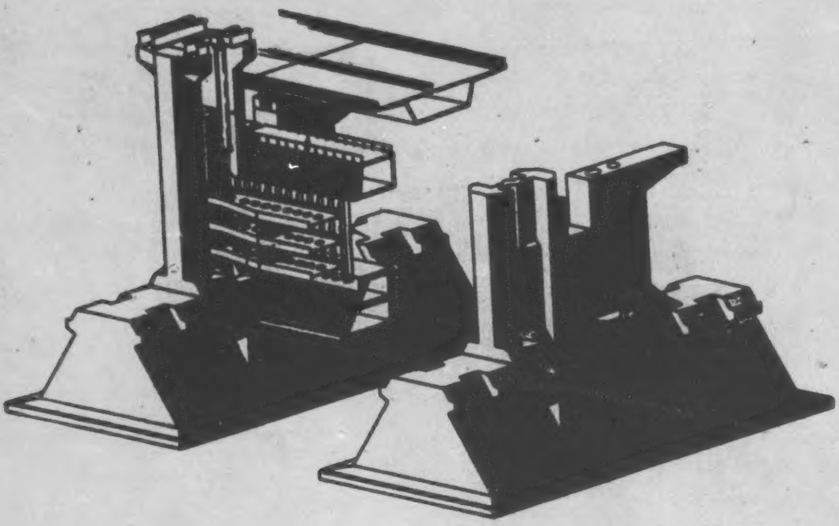


figure 4.

The barrier will have a total lenght of about 3 kilometres. About 60 piers will be placed on the bottom of the Easternscheldt, each with a weight of 18,000 ton and 50 metres high. This will be done by a ship specially constructed for this purpose. Between the piers steel gates will be hung, each 40 metres long, the largest of which weights 700 ton.

2.0 The barrier.

When the storm-surge-barrier will be put into operation in 1985, the control over the barrier will have to be so optimal that the object in view will be achieved, namely that the barrier provides:

a) safety for the Easternscheldt area during storm floods;
b) approximation of the natural tidal movement in the Easternscheldt.

Under normal conditions the barrier will remain open. However, if a storm approaches causing such high waterlevels that the dikes are threatened, the barrier will have to be closed.
The following problem arises, however:
At what moment must the barrier be closed and when must the barrier be opened, must the barrier be wholly of partly closed? What facts or what information can be used for guidance?
This problem has been elaborated on in the BARCON (Barrier Control) project, a mutual project of Rijkswaterstaat and the Rand Corporation (USA).

2.1 Strategies.

In the BARCON project several alternative strategies

have been developed for the closure and the opening of the barrier.
With the aid of, among other things, computer simulations the consequences have been determined of all strategies on the safety, the environment and shipping.

The aforementioned computer simulations have been made with a simulation model developed by the Rand Corporation. The model called SIMPLIC is a mathematical model that calculates the waterlevel in the Easternscheldt based on a given waterlevel in the North Sea (near the barrier) and a given aperture size of the storm-surge-barrier.
These calculations are evolved from, on the one hand, empiric figures (44 stormfloods between 1921 and 1970) and on the other hand from a certain numbers of extremely high stormfloods that could occur.

Also sensitivity analyses have been made for a number of strategies with regard to variations in wet cross-sections, inaccuracies in forecasts, values and so on.

2.2 One should keep in mind, however, that those strategies are based on "ideal conditions", that is to say that the following factors have not been taken into account: the organization structure of the control, the presentation of the information, the decisions taken by persons, based, based on this information. Briefly: the human factor.

These problems will come to the fore when the strategies are put to use. Around the operational aspect centres the recently started project BOTI. (The word BOTI is a combination of the initials of the Dutch words: Decisionmaking, Organization, Training and Information).

As far as the future decision-making regarding the handling of the barrier is concerned, we can tell that in principle two extremes can be distinghuished:

a) Use of a scenario only.

This implies that all situations that might occur will have to be diagnosed in the research-stage. All decisions c.q. (in this case) actions will have to be dictated in the scenario. The manager will not be able to make his own decisions as to how to operate the barrier.

b) Let the manager be the decision-maker.

It implies that only directives will be given for the control. This is clearly a case of a decision-making-process. The problem of making decisions and by whom is only one of the fields to be researched by BOTI.

Both the extremes mentioned here present difficulties. It is impossible to obviate all unforeseen circumstances in a scenario. Yet, in difficult situations, not exactly described in the scenario, the control manager will have to take duly motivated decisions.
On the other hand, not all decisions must be left to the manager. It is therefore sensible to develop, during the research-stage, strategies and tactics which can be employed under normal conditions. As said before, however, the operator will still have to take decisions in unforeseen situations.

We must realize that the barrier will only be closed on an average of once or twice a year*) and therefore it is absolutely necessary that the manager be fully trained beforehand and remain to be well-trained in order to be able to take the right decisions. For this purpose the SIMBOS has been designed (Simulation Barrier Oosterschelde).

*) This figure is based on the starting-point that waterlevels higher than the so-called B-level (NAP + 2.60 m) must be avoided. At the time of lower stormfloods the barrier must remain open in order to maintain the tidel movement. The strengthening of the dikes, which is in progress at present along the Easternscheld, must provide the necessary safety.

2.3 SIMBOS.

SIMBOS is an interactive model simulating the control of the storm-surge-barrier. During a certain amount of time the person operating this model is confronted with all kinds of simulated situations liable to happen to the barrier, thus forcing him to take immediate decisions as to how to manipulate the barrier. Before further exploring this model, we shall tell more about the demands we make upon such a model. What requirements must be met in view of the aforementioned aspects?
This model has in fact a dual purpose:

1. the training of the future operator;
2. the answer to questions arising during the research into the future control of the barrier.

ad 1. This item speaks for itself. The model has to be so constructed that a person can be trained in a simple way what decisions to make, when operating the storm-surge-barrier. The model is meant to have an auxiliary function and must not be too complicated.

Even somebody who has never worked with a computer should be able to handle the model.
This implies that communication with the computer should be simple.

ad 2. The computer must provice the possibility to study the following subjects:

- How well does the decision-making process work with the arrival of periodically updated information (forecasts of waterlevels and so on)?
  It is therefore necessary that every decision is registered as well as the information on which the decision was based.
- How sensitive are the developed strategies to inaccurate information?
- How sensitive are the developed strategies to the decisions of the operator?
- To find an optimal presentation of information:
  How are the decisions taken influenced by certain ways of information-presentation?
- Has the scenario to be written in detail? What must be left to decide by the operator?
- When deciding about the contents of the scenario: What does one require from the person controlling the barrier?

This implies that all kinds of data of a run will have to be conveniently arranged and also that there is ample possibility to vary the parameters so that their effect on the decision-process can be studied.

Next we shall further explain what the situation will be in 1985, when the barrier will be in operation. The model will have to simulate this situation as closely as possible. In this connection two facts are important:

1. What information does the operator receive?
2. At what moments does the operator have to make decisions? (At the construction of the model it has been taken for granted that the barrier will be continuously manned. Possible summons by the SVSD*) for additional personnel have not been taken into consideration.

   We purposely limit ourselves to decisions only concerning the opening and the closure of the barrier).

*) The SVSD is the storm-surge warning service of Rijkswaterstaat. Formerly it was called the Stormvloedseindienst (Storm-surge signal service), hence the abbreviation SVSD.

ad 1. a. The operator can directly read off the actual waterlevels near the barrier both on the North Sea side and on the Easternscheldt side. The same goes for the situation on the barrier itself. Both the aperture and the operation of the barrier can be read off.

b. From the KNMI/SVSD*) the operator will regularly receive the weather forecasts especially the expected high waterlevels of the North Sea near the Easternscheldt and the exact point of time of the high water. By means of a North Sea model, the KNMI (Royal Netherlands Meteorological Institute) makes a forecast every three hours at present. It is to be expected, however, that in the future, particularly for the management of the barrier, an even more accurate or more frequent forecast will be made. This subject is still being studied.

c. The manager will also be provided with less vital information, such as actual waterlevels on on the North Sea and in the Easternscheldt, its weather conditions, and so on.

d. From time to time the manager will receive information of a more general character, both by telephone or telex. It may be news from harbours in the Easternscheldt, messages from environmental groups, reports about dike-slips or even information that has nothing to do with the Easternscheldt.

e. When something gets out of order at the barrier, it is imperative that the manager receives the necessary data.

Apart from this type of information, the manager will have to have one or more strategies at his disposal.

ad 2. In principle the manager can decide at any given moment either to close, to open or, generally speaking, to change the aperture of the wet cross-section.

Still another number of factors also belongs to the decision-making process.
For instance, the decision to ask for information at a certain moment. The attention given by the operator to the course of the water-levels can be seen as a kind of decision. When there is no storm, he will control the water-levels less frequently. With a storm-surge he will be much more on the alert; from minute to minute he will want to follow the water-levels.
We therefore may conclude that the model must provide the following three forms of decision:

1. manipulation with the barrier;
2. enquiry of information;
3. selection of the point of time to observe the actual water-levels.

So far these are the demands that are made upon the model as regards to the expected situation when the barrier is in operation.

The SIMBOS has especially been designed to meet the above-mentioned demands.
SIMBOS uses datasets which have been compiled beforehand. Each datatset contains (part of a) certain historical storm-surge. (Those data are copied from an already existing storm-data set). Added are further information such as weather forecasts, deficiences and so on.
So, the dataset contains all data necessary for a certain run of the simulation. There exists an auxiliary program with which these datasets can be compiled.

The operator will impersonate the manager of the storm-surge-barrier. He will have to keep the water-levels in the Easternscheldt within the limits of the given strategy. He receives, as is usual, a new weather forecast regularly, among other things a high water forecast and can, moreover, be confronted with unexpected faults and reports of all sorts and conditions.
It is the task of the operator to sort out the information and to decide upon the size of aperture of the barrier during this session.

SIMBOS is so designed, that after each session everything the operator did can be verified, such as: what decisions did he take and when; what are their consequences on the water gradient, the minimum and maximum waterlevels, tidal ranges and so on. An overall picture will be given of three outputs: a table, a "plot" and a statistical survey. This, in combination with the applied scenario-method makes the model highly suitable for all kinds of research and training.

A very simple method has been selected to communicate with the model; the model asks questions of the "operator", who replies by pushing certain numbers. A kind of multiple-choice-system. This considerably reduces the chance of typing errors. The "operator" can now fully concentrate on his task:
an efficient management (control) of the storm-surge-barrier.

2.4 Results.

As the SIMBOS is still in the initial stage, not many experiments have been done as yet. From the experiments made thus far, we learned that it is not a simple matter to realize its goal (i.e. to obtain a certain water-level in the Easternscheldt) without the aid of a strategy.

3.0 Conclusions.

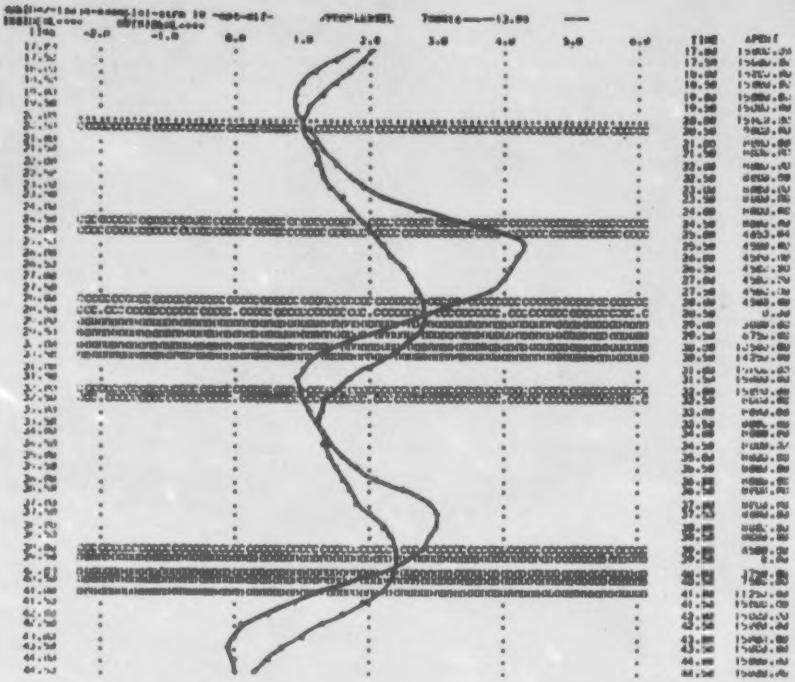
At the end of 1979 a strategy will be selected based on the outcome of the BARCON research project. Then the projectgroup BOTI will assemble a research program based as a starting-point on the selected strategy.
During the subsequent research the model SIMBOS will be put into use. At the moment there are plans for a SIMBOS II. In this new version no historical storm flood will be used.
Through SIMBOS II we will gain an insight into the decision-making process, among other things, during extreme conditions both as far as stormfloods and other circumstances are concerned.
Later versions of SIMBOS will be specially aimed at: -

a) training: both the training of the manager and the training of the total organization.

b) Its use during the actual operations of the barrier (after 1985).

```
TIME:16.24  OWL: +0.11  IWL: +0.27  HEADDP: -0.15  STATUS:--       APERT:  15000
-------------------------INFO2-----------------------------------------------
---TIME :16.24  HR.
---MESSAGE---
heavy weather on northsea ; depression moves eastward to holland

-------------------------END INFO2-------------------------------------------
?
0
TIME:18.00  OWL: +1.26  IWL: +1.72  HEADDP: -0.45  STATUS:--       APERT:  15000
NEW INFO! AVAILABLE
?
0
TIME:19.00  OWL: +0.94  IWL: +1.29  HEADDP: -0.34  STATUS:--       APERT:  15000
-------------------------INFO2-----------------------------------------------
---TIME :19.00  HR.
---MESSAGE---
from fishing-companies: please do not close the barrier in such a way that a stagnant waterlevel occurs

-------------------------END INFO2-------------------------------------------
?
60
TIME:20.06  OWL: +1.04  IWL: +1.06  HEATDP: -0.01  STATUS:--       APERT:  15000
?
4

*****************************************************************************
---TIME :20.06  HR.
        --ACTUAL APERTURE BARRIER:  15000  M2
        --BARRIER OPERATES NORMALLY
        --WHAT APERTURE DO YOU WANT TO ADJUST? (GIVE IN SQUARE METERS)
?
8000
        --THE APERTURE YOU ADJUSTED WILL BE REACHED AT  20.34  HR.
*****************************************************************************

TIME:20.12  OWL: +1.06  IWL: +1.06  HEADDP: +0.00  STATUS:CLOSING   APERT:  13500
?
60
TIME:20.48  OWL: +1.21  IWL: +1.11  HEADDP: +0.10  STATUS:--       APERT:   8000
-------------------------INFO2-----------------------------------------------
---TIME :20.48  HR.
---MESSAGE---
harbour wemeldinge asks for waterlevels >2meters ,when it is decided to close the barrier

-------------------------END INFO2-------------------------------------------
?
900
TIME:21.00  OWL: +1.25  IWL: +1.13  HEADDP: +0.12  STATUS:--       APERT:   8000
NEW INFO! AVAILABLE
?
0
TIME:23.30  OWL: +2.29  IWL: +1.68  HEADDP: +0.60  STATUS:--       APERT:   8000
-------------------------INFO2-----------------------------------------------
---TIME :23.30  HR.
---MESSAGE---
ship "entertainer" in northsea in distress,ship is redderless

-------------------------END INFO2-------------------------------------------
```

```
YDEL!
---RUNIDENTIFICATION:/-image-example!-strm 19 -opt-dif-       /PROBEERSEL     780816-----13.05     --

  TIME    ONLEVEL   INLEVEL    INLMND     APERT      FAILAPERT    FAILBAR    FII      SINF
 22.50     1.76      1.30       1.23     8000.00       ---          ---      111
 23.00     1.90      1.49       1.31     8000.00       ---          ---      111
 23.50     2.30      1.61       1.30     8000.00       ---          ---      111     2
 24.00     2.70      1.76       1.49     8000.00       ---          ---      121
 24.50     3.45      1.94       1.61     8000.00       ---          ---      121     D
 25.00     4.10      2.10       1.74     4653.84     4500.00     10384.62    121     3
 25.50     4.31      2.24       1.91     4500.00     4500.00     10384.62    121     2
 26.00     4.27      2.30       2.10     4500.00     4500.00     10384.62    121
 26.50     4.10      2.51       2.20     4500.00     4500.00     10384.62    121
 27.00     4.05      2.63       2.34     4500.00     4500.00     10384.62     10     2
 27.50     3.81      2.74       2.40     4500.00     4500.00     10384.62     10
 28.00     3.44      2.83       2.63     4500.00       ---          ---       10     3D
 28.50     2.96      2.85       2.76        0.00       ---          ---       10
 29.00     2.58      2.84       2.67     3000.00       ---          ---       10     D
 29.50     2.85      2.76       2.65     6750.00       ---          ---       10
 30.00     1.96      2.58       2.96    10500.00       ---          ---       21     2
 30.50     1.31      2.32       2.87    14250.00       ---          ---       21     2
 31.00     1.81      2.02       2.87    15000.00       ---          ---       21
 31.50     0.97      1.74       2.86    15000.00       ---          ---       21     2
 32.00     1.83      1.51       2.66    15000.00       ---          ---       21     D
 32.50     1.09      1.30       2.33     8000.00       ---          ---       21
 33.00     1.17      1.31       2.01     8000.00       ---          ---       11
 33.50     1.26      1.27       1.75     8000.00       ---          ---       11
 34.00     1.36      1.30       1.50     8000.00       ---          ---       11
 34.50     1.46      1.35       1.42     8000.00       ---          ---       11
 35.00     1.63      1.42       1.38     8000.00       ---          ---       11
 35.50     1.83      1.50       1.41     8000.00       ---          ---       11     2
```



-2.0
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3.0
4.0
5.0
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TIME

5.3 In medical training.

5.3.1 Drs. J. H. G. Gerritsma and drs. J. A. Smal, Department of Medical Education Research and development, University of Utrecht, The Netherlands.

Realism and adult education: an analysis of the consequences of two design approaches for simulation in continuing medical education.

Written clinical simulations

For purposes of training and evaluation of medical decision making patients are simulated in a written format of questions and options concerning obtaining a medical history, conducting a physical examination, ordering laboratory studies and making patient management decisions (McGuire, 1976; van Es et al, 1977). These written exercises start with a short description of the patient and the patient's problem is introduced with a brief statement of the complaint. The information about the patient's condition is couched in realistic terms. It is not presented in classic textbook or conference style. All the decision categories such as history, physical examination, laboratory and therapy lists are made with correct and incorrect options. The medical students or physician is supposed to select the proper options in the context of the complaint of the patient such as the physician might elicit from the patient himself. He makes a choice by revealing that answer to each question or option he has selected. Step by step the student has to decide what further steps or choices would seem necessary on the basis of these new data revealed by previous choices until he has solved the problem. If the student selects harmful actions or fails, for example, in taking measures essential to the recovery of the patient, informative feedback is given regarding complications the patient will encounter. There are different written formats for providing the above medical information. For instance: books have been published which have the so-called latent image printing technique (McGuire, 1976), red filter print (van Es et al, 1977) or assisted by the computer (Hoffer et al, 1972). These written simulation techniques have become more and more important in medical education, especially for teaching and evaluation purposes.

In this paper we shall discuss:

1. Construction rules for the classic written clinical simulation
2. The ineffectiveness of this method for experienced physicians who want to use these simulation techniques for continuing their education (adult education)
3. Methodological implications for the design of simulations for these physicians on the basis of their criticisms
4. A method for simulating doctor-patient encounters, which is more appropriate for training experienced physicians.

Design principles for written clinical simulations

There are various books (McGuire, 1976; van Es et al, 1977) about how to construct written clinical simulations, which systematically deal with the design principles for this format. Some of the essential rules are summarized below.

According to McGuire (1976) the selection of a suitable medical problem is the first in a series of crucial steps in constructing a written simulation. That choice should be guided by three considerations:

1. The purpose or objective of the simulation exercise
2. The general knowledge and skills it is to foster or to assess
3. The level of expertise and stage of development of the students with shom it is to be used.

Furthermore the purpose of the simulation should be defined in

measurable behavioral (instructional) objectives.
Mostly these objectives refer to:
"Skill in eliciting historical and physical information from the patient"
"Skill in making a diagnosis of acute appendicitis"
"Skill in suggesting a proper treatment regime"
Following the first step the designer then considers the various problems that would appear, to involve these objectives in a relevant content area and begins to outline the sequence of events that will occur in the simulation. The following rule is of great importance: "In preparing this outline the author will need to consider the kinds of errors that students may make in attacking and solving the problem and to determine the consequences that will ensue from each of these major events.
The design process is completed by preparing a detailed scenario much like that which a novelist or playwriter develops. However, a written simulation must contain, in addition to the correct or proper "story line", an outline of the alternate sequences of events that will occur should the medical problem solver take a wrong turn and of the different endings for all these variations of the story. This type of written patient simulation is called a branching simulation, in contrast to a linear simulation where every student must go through the same sequence regardless of his "good" or "bad" choices.
A written simulation is graphically illustrated in figure I.
The most popular form in which written clinical simulations are presented in bookform with the so called latent image printing technique. Simple and uncomplicated simulations need about 20 pages. If however, the problem is complex and many branches are introduced (because of the many possible decisions that can be taken by the doctor and which involves changes in the patient's situation) about 40 to 60 pages are needed. Often reductions in complexity or in the number of branches have to be made in order to produce a simulation

of manageable proportions. When participants have to work through bulky problems they will soon lose interest and thereby miss a chance to acquire new skills.

Problems encountered with the adult education of experienced physicians

Written simulations work well with students and have also been used for continuing adult education of the experienced physician. However, in a recent survey (Gerritsma & Smal, 1979) most Dutch doctors said that while they could work with these simulations in a way that resembled their daily practice methods, their general impression was that these simulations were more suitable for students and not useful for their purposes. They said, they felt hampered by the simulations in that they had to follow many detailed instructions and they could not work as fast as they did in daily practice with real patients. In addition the simulation format dit not allow them to ask history questions during the physical examination section. In other words, despite the use of branching the simulations were still too inflexible to be realistic. In our attempts to adapt these written simulations to the specific needs of the experienced physicians we encountered two fundamental problems on design issues:

(a) Complexity and credibility

One design variable frequently used to make simulations suitable for different target groups, i.e. different as to level of education and experience, is to apply the principle of variation in the complexity of the problem.

This might imply that for experienced specialists we would have to develop more complex medical problems. However, the increasing complexity of the simulation may give rise to other problems (as indicated by Dittrich (1977)). He found that credibility, which is called by Elder (1973) the raison d'etre for educational simulation, appears to depend on the complexity of the simulation to some extent but does not automatically increase as complexity or reality is modelled or simulated more precisely. He compared three simulations, which differed in credibility and complexity and his study showed that the moderately complex simulation had the greatest credibility for the participants.

So if we were to increase the complexity of the simulation it would not automatically imply that we would produce a more credible simulation for the experienced physician. This was aldo pointed out by Feldt and Goodman (1975) who clearly stated that "game designers should not become seduced by the lure of adding detail and realistic interest to a game until it becomes overburdened with details which make it largely incomprehensible (...). The important principle in good design is to keep things out of games, not to put them in".

Clearly increasing the complexity of the medical cases would not solve the problem of unrealism for the adult learner.

b Medical realities

A special problem concerning the increase of the complexity of the simulation is the knowledge of medical reality of the designer. This knowledge is based on application of scientific principles and causalities in the treatment of deseases and problems of the patient. In multiple branch techniques the consequences of decisions, e.g. negative results due to wrong medicine, or a necessary operation not being carried out, must be worked out in the simulation. The views and medical expectation of the medical instructor who is constructing the simulation are then made quite explicit.

The adult physician learner, working through the simulation, may react to the medical designers scenario negatively, because he has a different medical view of medical reality and medical causalities. This apparent difference in practical experience of reality between designer and experienced physician becomes of paramount importance to the adult learners' acceptance of the validity of simulation and the learning it produces.

In extreme cases he will refuse to participate further in the learning experience.

Generally an experienced doctor who wants to participate in educational programs for continuing education finds himself playing a somewhat paradoxical role. On the one hand, he wants to learn things that are directly applicable and he is prepared to be a "student". On the other hand, he wants to have his professional knowledge acknowledged and does not want to play the role of the naive and passively accepting student. If the designer is not fully aware of this dual role, the physician will become frustrated in participating in the simulation and will not experience this process as a meaningful learning experience.

Clearly, physicians have different views of medical realities upon which simulations are based. Medicine is not yet an exact science on which all agree and these different views of reality are accentuated with the experienced adult learner. If patient simulations are to be used for this purpose, the simulation must be designed in a way that will minimize the differences between the experienced learner and the simulation designer.

Psychological characteristics of the adult learner

The following description of some important characteristics of the student role of experienced physicians draws heavily on the insights of Gardner (1978) and Knowles (1970). "Providing correct health care instruction requires didactic and clinical faculuty in any speciality area to continually update their skills in order to prevent obsolesence. However, while faculty members can be viewed as students in educational programs for continuing education these professionals cannot be viewed in the same perspective as the student who has not completed his speciality preparation and entered a health profession. The adult, as a student in a short term learning experience, must be accepted as a professional person. In contrast students view themselves as individuals who are engaged on a full-time basis in going to classes, working on assignments, taking tests, writing papers and getting grades.

The adult learner views himself as a "producer or doer" who is basically self-directed and in control of his learning choices, experiences, activities and evaluations. Therefore, the perspective of the adult learner is that of an independent rather than a dependent student.

The characteristics of the adult learner have important implications for program design, presentation and management. Because of his adult status and his self-concept the adult learner demands programs that understand and accept this self-concept, treat him as an adult and provide opportunities for him to function as an adult. Program situations which cast the adult in the role of the dependent student are likely to produce negative results. The adult is likely to reject being talked "down" to embarrassed, punished or judged.

The learning environment is very important. In adult learning groups, the teacher or leader is seldom viewed as a person with authority. The teacher or group leader should discuss problems as adult equals. Despite his need for new learning experiences, the adult has a strong need for security in the learning environment and maintenance of one's self-image of adult responsibilities. As we have seen in the previous section simulations that were acceptable for student learning tend to fail when used for adult learning of the experienced physician. The design principles for these simulations failed to account for or anticipate the reactions of the adult learner who is clearly different from the student learner. The adult, because his experiences and past learning are such an integral part of his being and self-concept, brings them to the education program. His expectations and needs are that some use will be made of his knowledge and experience and if this does not occur or if the worth of his experiences is minimized or discounted a feeling or rejection and frustration results. He values his experiences and because he does value them, he feels they represent an investment of himself.

General design considerations for adult learning

How can we construct a simulation in order to meet the unique needs of the adult learner? If we take the previous views of adult learning seriously the physician has to be in control of his learning choices, experiences, activities and evaluations. The design approach by McGuire (1976), van Es et al (1977) seems to be incomplete for this objective. The approach is similar to what Easterly (1978) has called model building using a forward design approach which is an ordered and scientific approach. This approach has a number of disadvantages, which Easterly has formulated as follows:
"A clear statement of one's objectives is often suggested as the first step before model building can begin. This approach to game design assumes that a real world exists out there to be observed, interpreted, sifted, sorted and translated into a model (...)".
"Since the process of observation and interpretation are preceptual ones, the small bits drawn from one's environment do not constitute reality itself, but rather, the game designer's perceptions about reality. As a result, the perceptions gleaned by one game designer will vary when contrasted with those perceptions which have been gleaned by others. Flowing from this whole process is the danger that reality may be distorted, since the game designer's perceptions may be inaccurate. The necessity exists, therefore, to examine one's perceptions carefully in regard to their relative degree of

accuracy in representing real-world counterparts".
This danger mentioned by Easterly was evident in the conflict of realities of the experienced physician and the simulated reality produced by the medical designer or teacher.
Easterly compares this "forward building approach" with an opposite approach which he calls "model discovery" and which in contradiction to the former approach appears to be disorganized and lacking in discernible structure. Designers using this approach seem to "begin with the end and end with the beginning". The backward design begins with an inkling of an idea (...) and the simulation begins to take shape precisely because no specific goals were formulated and no precise model was built.
The conclusion of Easterly after the comparison of both design approaches is:
"that danger lurks for the potential designer who exclusively embraces either "the building" or "discovery" approach. The objectives and models posed at the beginning of the first approach tend to limit the "reading" taken of the real world, thereby restrict creativity. Conversely, the latter approach may prove to be totally inadequate for the game designer who possesses no model at either the explicit or implicit level. Thus, a game designer who is asked to research and develop a game describing an unfamiliar system must be able to think "forward and backward" in an almost simultaneous manner for each step in the development process. This can be called an integrated design process to differentiate it from the forward and backward approaches.
In order to make an acceptable simulation that was suitable for experienced physicians we were forced to use this approach in order to meet the objections used against the simulations using the forward design approach.

Methodological implications for the forward and backward approach

The first question is constructing a simulation game for experienced physicians is: What is the general approach? In most cases the formulation of the general approach states that a doctor should be trained in "higher cognitive skills like medical reasoning" or some other specific learning objective. But there are also other alternative conceptions of the purpose simulation games should fulfill in education. For example: simulation can be used to present abstract models of reality in experimentially rich and concrete forms. Participants participating in these simulations are not expected to develop prespecified cognitive, psychomotor or affective skills as a result of participation but are expected to describe analyze and evaluate the realities to which the simulation refers.

These two purposes can be incompatible. An attempt to use a simulation game to present a model and to teach skills simultaneously is not likely to achieve both goals equally well. (VanSickle, 1978).

It is better to make a clear choice between these two approaches. It seems to us that the second approach "presenting models" better meets the need of the adult learner than the first, which requires specification of learning activities. The presenting models approach has some implications for the design, which is clearly different from the design approach by McGuire, et al. There must not only be a matching of the selected medical problem and the teaching objectives but also a compatability between the selected problem, the teaching objectives and the specific expectations of the target group.

Isomorphism within medical reality

In constructing a simulation model we first used a written simulation (PMP) with branches. This model however imposed too many artificial limitations on the actions of a doctor with experience in every day medical practice. There was an obvious need for greater isomorphism. It was clear from the comments of the experienced physician that they needed complete freedom of action from beginning to end of the patient encounter. Patient history, physical examination, and laboratory study decisions could occur at any time and in any combination. Random access to information resulting from such learner actions had to be incorporated into the design of the simulation format. Blocking history taking choices together and separate them from physical examination choices, for example, would not satisfy experienced physicians, nor would a few branching sequences that were appropriate to major medical treatment decisions suffice. The written patient simulation format had to be abandoned in favor of a more flexible method that would allow each physician to experience the sequencing of reality that he was familiar with. Isomorphism of the scenario sequence was almost more important that the complexity of the case or disease of the patient being simulated.

Furthermore, some way had to be found to avoid specific feedback of negative consequences on the patient due to bad decisions made by the physician. Expert judgment of such hypothetical consequences on the patient proved to be too controversial and threatening to many of the experienced physicians. The design principle of incorporating realistic feedback for medical actions taken had to be modified in a way that did not invoke controversy with experienced physicians hold views different from the designer and teacher. Summarized below are specific design decisions we made to construct a simulated medical reality that would seem to satisfy complaints made about the written clinical simulations tried previously. The paper concludes with a brief description of the way the medical case materials are organized to meet the demands of a completely flexible scenario for each participant.

Specific design decisions for medical problem solving simulations

1 Real patients

In constructing the model of the patient we have taken real patients that a doctor comes across in his daily practice. We have had to make alterations or extentions of the patient data because of the fact that many questions and procedures that were never really undertaken with the real patient still had to be answered in the simulation. We have altered the answers and results in such a way that they will not essentially affect the medical outcome of patients being simulated.

2 Cooperative patients

One of the aims was to enable the doctor to treat the patient from beginning to end, without the patient arbitrarily stopping the treatment halfway as frequently occurs in real life. The patients are most cooperative and only rarely refuse treatment even if the patient would experience the prescribed treatment as injurious or harmful. There is a limit, however. For example patients will refuse to submit to a tracheotomy. Now if the doctor decides to have this tracheotomy, the patient will refuse but will not go to some other doctor, simply because he has lost his faith in his doctor. After all patients have some rights and this is the way we show their potential behaviour.

3 Influence of time and health factors

In most cases the time variable has been worked out in such a way that all the crucial data of the patient gradually improve, regardless of the kind of decisions that may and can be made. The patient recovers his health in the course of time. We assume that a large number of doctors will correctly diagnose and use the right approach to patient treatment. There may be a number of physicians who according to other experts will fail to manage the patient correctly but they also appear to cure the patient. It is therefore important to record what incorrect treatments were administered but it is not necessary or important to inform them about the negative consequences of their treatments during the playing of the simulation.

This can be discussed after the case when their views and sensitivites and experiences can be taken into account by the teacher.

4 Separation of decisions and medical consequences

Another important aspect of the model which is closely connected with no. 3 is the separation of decisions and the medical consequences of these decisions. To include the medical consequences in a model seems a very essential thing to us when a simulation model is used for students, but it is not a suitable vehicle for more experienced specialists. First of all it is sometimes very difficult to assess the consequences of certain acts. One expert will violently disagree with another expert, which might result in a purely technical discussion. In addition to this a doctor who feels he is confronted with an "irrelevant" consequence that does not agree with his experience, will no longer be motivated to take part in the simulation. He may opt out of the following discussions where new learning takes place; or he may refuse to participate in an educational setting any longer, because he feels that he has been questioned on medical grounds. Since the primary goal of teaching adults with simulations is to have the physicians make the same decisions they would do in real life and then discuss these decisions if they are inadequate or not based on new medical knowledge. Consequently it is theoretically conceivable that a doctor will seriously harm a patient by prescribing a totally improper medicine, that could cause his death. Yet the patient will still be able to see his doctor next week. The approach we deliberately selected is such that the patient will be cured regardless of what the doctor has decided to do in the course of his treatment. The essential thing is that the doctor takes decisions and continues. He will explain and discuss his actions afterwards in a group in a way that is acceptable to him. This discussion is the teaching or learning situation for adult education. The simulation provides the subject matter and context for subsequent learning.

5 Combination of "types of answers and events"
There is quite a difference between the first time a patient consults his doctor about a specific complaint and the second or third time when he is under medical treatment. Then the patient is sure to remember certain details and events which took place in the earlier simulation process. This must be accounted for in the patient's answers to the same questions asked at different times.

6 Random variation
Certain answers or results will sometimes show a random variation. For example, when a patient has a high blood pressure at first, it will gradually improve. If the doctor decides to measure blood pressure a number of times (left arm, right up, sitting, standing up, etc.) the patient's blood pressure will fluctuate as it normally does in reality. In so far as certain changes are to be expected they are included in the model in order to add to the credibility of the simulation.

7 Time-lag
The time interval between asking for a technical and laboratory examination and getting it must be accurately modelled. In critical situations it is very important to collect laboratory data early in the patient encounter. The results,

which come back later will of course have a great influence on the treatment the doctor will prescribe. In the model we have included the interaction between the moment of asking for a laboratory examination and the moment when the results are available from the laboratory. While it is possible to ask for the examination at any time the results will be available depending on the type of test ordered, during the consultation session, after a day, or possibly after a week. The same goes for the technical examination.

The incorporation of these seven facets of clinical reality into a practical simulation format that allows complete decision flexibility for the participating physician required us to employ an individual to administer the case. The format is described in the following section.

Description of the format of the simulation

The simulation consists of a great number of decisions which can each have a different result. It is up to the doctor to take various initiatives, such as asking questions, physical and diagnostic examinations, biochemical and biotechnical examination, consultations, referrals, therapeutic treatment and advice and decisions as to the continuation or stopping of the patient's treatment. The first problem that has to be solved in a "mammoth" section in which there are two or three hundred decisions possible is: how does the doctor arrive at his decision (his choice). How this problem is solved directly concerns our field of study: the thinking process of a practising doctor. Most studies have shown that after a few symptoms have been mentioned by the patient the doctor has already formed a number of hypotheses and attempts to corroborate or refute these hypotheses by asking for more additional information. So the doctor himself generates the following questions and must be able to find this question without any obstruction. When he is obliged to go through long lists of other possibilities he may be influenced and form new hypotheses, which affect the original number of hypotheses he had.

We have tried to facilitate this finding process as follows:

a) All the decision possibilities were selected according to the following criteria

- they had to be subject independent to avoid cueing
- they had to conform to the normal classifications as used by the people used as subjects for experiment.

This means that a classification with tractus as well as one with "top to toe" because internists tend to work with a tractus classification and family doctors with a more general one.

Decision possibilities which could fall under several headings were repeated under every subject. For example: "the question about shortness of breath is found in tract respiratorius, tract ciruclatorius and also under thorax and physical condition.

b) All the questions are formulated with keywords or in telegraphic style. This facilitates fast reading. This does however mean that no special importance should be attached to this "form" of questions.

No hypotheses about this subject are formulated and the participants were told that this aspect had not yet been worked out (In previous simulations we had tried to differentiate the question "forms" and to combine them with other consequences). There is very little concrete theoretical work about this and written simulations tend to be less suitable for an investigation of interaction variables than for example actors' simulations.

c) To increase the accessibility of the grouped questions, the questions were arranged in a subject index system. The subjects were printed in fat letters on the tabs of the subject index, so that at any moment during the simulation the participants can take in at a glance what subjects are used as classification principles. By opening the index system at a particular subject he will find the decision possibilities. This system has been arranged in such a way that all the subjects are easily accessible.

The format we have developed for use with experienced physicians bears some similarities to the Patient Games developed by Maatsch et al (1974) and the Problem Boxes of Barrows (1976) but has the additional advantage of standardizing and identifying all questions and sections in the sequence in which they are taken. This feature makes the simulation format an excellent research method to study difference in the quality of physician performance and different styles of patient care as well as factors influencing medical decision making. At the same time, the format seems to provide a flexible learning vehicle for students and experienced physicians alike. This feature would allow use of the same simulated cases, once developed, to be used more widely in a variety of educational and research settings.

Some preliminary results of field tests

We have developed 4 problems in the above format and administered them to 10 experienced physicians to test the usefulness of this format or model and its suitability for use with physicians.

After each run we gave the participants a questionnaire to investigate whether the described model is more suitable than the more fixed written simulations described by McGuire and tried previously. Nearly all doctors responded that they could think and operate in the new model in the same way they were used to in real practice.

The range of possible actions were more or less complete and those options which were not modelled but requested, did not seem to be disastrous for continued play. The manageability and accessibility of the system were sufficient, the answers of the patients results of test etc. were felt to be realistic. Perhaps more importantly the simulations did not induce associations or therapeutic actions by physicians which would not come into mind during real medical practice.

Physicians seemed to enjoy participating in the simulation and did not react negatively or become threatened by the design of the simulation of a patient. Learning from participation in the simulation can occur in post-exercise discussions where the needs and sensitivities of individual learners can be more carefully considered by the teacher or better the discussion leader. We believe these simulations can be viable teaching and research vehicles in all kinds of educational and research settings.

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Computer simulation in problem oriented medical learning.

Introduction

In medical education there is a constant need for developing new learning methods. Several systems and processes are so complex that verbal explanation of these systems and processes in quantity and quality may be very ineffective.

Simulation as a learning method can be used as a powerful method in problemoriented learning. A good method of simulating a biological system or process is computer simulation of a model of that system or process, if it is possible to describe the biological system or process as a set of mathematical equations.
Alternatively, computer programs may be used that are based upon inquirydialogues rather than mathematical equations. There are different ways to realize this on a computer:

- Using simulation languages. Such languages are very flexible tools for simulating; however, such languages do not seem suitable for medical students because of their command-like structure.

For a medical student a conversation with an interactive computer program would be preferable.

- Using Computer Assisted Instruction (CAI). This method of self-learning with a computer, without knowledge of programming, is called CAI. A computer program by which a student learns is called a CAI program.

Since 1978 our project-group at the Medical School of the State University of Limburg investigates the possibility of modelling and simulation of systems and processes from biophysics, biochemistry, pharmacology and physiology for CAI use.

In literature there are a number of examples of simulation with computers. Most of the models have not resulted in a CAI program, but they give us the opportunity for further development of these programs into CAI programs.
Experiments with CAI in several countries, over a number of years, as indicated by several studies, show good net results. With a CAI program it is possible to explain and investigate complex biological systems and processes without the help of a teacher and motivate the student (Dijk, 1979).
The use of CAI is growing now, partly because prices of computers drop constantly.

1. Method of simulation-based CAI program development.

A CAI program based on a logical process or a mathematical model, - a "simulation-based CAI program"-, starts with the investigation of the mathematical model, the model parameters and the model behaviour. Suppose a system of differential equations $\dot{\bar{X}} = A \dot{\bar{X}}$ with A is a (2x2) matrix.
Thus:

$$\frac{dx_1}{dt} = a_{11}x_1+a_{12}x_2$$

$$\frac{dx_2}{dt} = \text{....} \text{ with } x_1(0)= 1.0 \text{ and } x_2(0)= 0.0$$

When studying this system we prefer numerical integration methods using a simulation language.

Some simulation languages are CSMP from IBM, ISL (ISL, 1974), THTSIM of the Technical University of Twente and ASP (Coleman, 1979). Using ISL as a next step, the system can be written as follows (fig.1).

A list of an ISL command file:

```
1 POT 3, xxx
2 POT 6, yyy
3 INT 1.0,1,2
     .
     .
     .
6 INT ...
```

Each statement is a process. POT (potentiometer) is a multiplying process and INT (integrate) is an integrating process. Changing the structure of the model or a parameter value can be done interactively and without a compilation step.

THTSIM and CSMP are comparable simulation languages.

An other kind of simulation language is ASP. The same example as above is written as follows.

A list of an ASP source file:

```
C  MODEL:
   DX1DT= A11*X1+A12*X2
   DX2DT=       ......
   X1=X1+DX1DT*DT
   X2=X2+DX2DT*DT
100 CONTINUE
```

with A11=a_{11}=xxx, A12=a_{12}=yyy, DX1DT=$dx_1(i)/dt$, XI(on i=0) is $x_1(0)=1$ and X2(on i=0) is $x_2(0)=0$.

X1, X2, DX1DT and DX2DT are variables and A11, A12, DT are parameters with a constant value.
If the integration step DT=$t_{i+1}-t_i$ is small and the model is a part of a program loop, the variables are calculated for each integration step. However, ASP needs a compilation step like FORTRAN.

The last step in programming is the development of the CAI program itself. A CAI program adds to the basic (mathematical) model of the system or process a number of student-oriented possibilities to interact with the model via the terminal. Such interaction may be e.g. possibilities to change system parameters, the generation of questions relevant to the model, etc.

We have opted for the higher computer language FORTRAN IV, not for BASIC or special CAI programming languages PLANIT or TUTOR (Dijk, 1979).
The exchangeability of ASP and FORTRAN is an advantage in this case.

Sofar we have used three CAI programs:

- The CAI program ANAMNESE based on an inquiry-dialogue
- The CAI program AORTA based on a physiological model
- The McMasters CAI program MACDOPE based on pharmacokinetic relationships and a multi-compartmental model of the human body.

2.1 The CAI program ANAMNESE.

The program ANAMNESE has been developed in the Institute of Nuclear Medicine of the State University of Utrecht (Min 1978 and 1979). The Hewlett Packard 2100 computer system of this institute (normally used for scintigraphic image processing of dynamic studies) was used for CAI development (fig. 2).

The CAI program ANAMNESE communicates with 8 different files or databases. There are two kinds of files: on the one hand alphanumerical editable data on sequential files and on the other numerical data on random access files.
There are two edit programs: a HP text editor and a numerical data editor, specially developed for updating the patient data. Furthermore, there is a stock program for a list of all questions and answers contained in this ANAMNESE system, the output of which can be used by the teacher for patientdesigning. These questions and answers are classified into II organ systems (tracts), and in main complaints and details.

The program is not based on a model, but on a process structure of a question database (600 questions), an answer database (2000 - 3000 answers) and a patient database (5 patients) and simulates a doctor-patient encounter for training the outline of the anamnesis.

The philosophy behind the development of this program and the investigations into the process of the anamnesis, was to give medical students a review of the anamnesis, independent of accidental patients present in the hospital. Therefore, the student needs the help of a wide variety of (simulated) patients. The teacher designs a patient on the basis of the checklist. The programmer collects the data and some personal data and puts these data in the patient database. Then the students are able to use the "patients". After an introduction of the program, and the generation of patients' personal data, the student can ask the patient one of the 600 questions from one of the 11 tracts. If it is a relevant question, and the patient answers, the program gives further possibilities for questioning.

A feedback system of massages and multiple choice questions (mc-questions) has been developed. A message or a mc-question (f_i) is given at the same time the answer of the patient is given and depends on earlier questions (q_n) and answers (a_m) which have been recorded by the program (fig.3).
A message gives more information about diseases or complaints on points in time where this is relevant, whereas mc-questions test a student. After such an interruption the "interview" is continued.
The student has the possibility to backtrack the status of the anamnesis as recorded by the program as positive (+) or negative (-) scores. This is displayed on the screen as:

```
fever               -
tiredness           +
pain on the chest   +
......              -
```

Furthermore the student has the disposal of 23 special commands. He can ask clarification how to continue the anamnesis. He can get an overview of the tracts and the questions of a tract. And he can ask for suggestions about the diagnosis as the teacher would give it and continue the interview.

Experiences with several students show that this CAI program is an interesting way to motivate students in their studies of medical decision making. At this moment the program is converted from HP to DEC.

2.2 The CAI program AORTA.

This program AORTA simulates basic hemodynamics in human aorta. The program is based on a simple mathematical model which was developed first whith the simulation language THTSIM. The model consists of 3 segments: the left ventricle, the aorta and the peripheral circulation, the right atrium included. The left ventricle is a pump, which pumps the blood into the aorta (diastole: 0 mm Hg; systole: 120 mm Hg). The pressure in the aorta depends on blood volume and aorta capacity. Blood volume is a function of the flow into the aorta and of the peripheral resistance. The capacity of the aorta depends on the compliance (fig.4). The analog model is given in fig.5. The pressure difference between left ventricle and aorta causes the aorta inflow, depending on the aortic valves as a non-linear element.
The program first gives an introduction in modelling by a programmed instruction.
The structure of the program is as follows:

1. the aim of the program
2. the 3 compartments of the aorta model.

3. the physical concepts: - peripheral resistance;
   $q = f(R, p)$
   - compliance; $V = f(C, p)$
4. the estimation of the input function: ventricle pressure and ventricle frequency
5. the estimation of the compliance of the aorta
6. the estimation of the total peripheral resistance
7. some facts about numerical integration
8. the simulation itself: results; diagnosis; changing parameters to simulate disease states.

The program is ready for use on a floppy disk of the computer system for CAI at the university of Limburg (PDP11/03, RT 11 operating system with graphic terminal VT55).
In 1978/1979 40 medical students in their first year used this CAI program, with the help of a teacher, in a course on arteriosclerosis.
They used this program for 1 - 2 hours in small groups.
A student can change the values of the parameters of the model and plot the pressure curves of the ventricle and aorta. In this way he can learn basic hemodynamics. The program also contains some cases (arteriosclerosis, hypertension). The student chooses a case and after studying the case and understanding what is happening, he can change parameters to obtain the normal pattern of the aorta pressure. For instance it is possible to simulate arteriosclerosis by changing the compliance (C_{ao}).

The results of the computation with the chosen parameters in the model are displayed on the screen of a graphic terminal (fig.6). Two curves are to be displayed in a grid. The upper one is the ventricle pressure (p_{lv}) and the lower one the aortic pressure (p_{ao}).

Some other data are displayed on the screen in the same time, to give the students enough information to draw conclusions.

In our opinion simulation with CAI is a good approach and a valuable addition to the study of biomedical systems and suited to learn interactions in physiology.

2.3 The CAI program MACDOPE.

The program MACDOPE, developed in Hamilton, Canada, at McMasters University, simulates basic pharmacokinetics. It is based on a system with a patient database (7 different patients), a drug database (17 different drugs) and a pharmacokinetic model consisting of 8 compartments (Block, 1974) (fig.7).
The program is implemented on the same DEC computer as the AORTA program and is minimized to 28 kw in core by making a sequential editable text file that contains all texts of MACDOPE, in addition to which the lay-out of the frames on the screen has been adapted.

MACDOPE does not use parameters like half-life or volume of distribution, but rather it is based on physiological principles. For instance, drug half-life cannot be changed as such, however, changing glomerular filtration rate or liver function results in different half-lives.

Graphical printouts of drug concentrations in all the compartments are possible, when a good prescription has been written on the screen and given to the model (fig.8). There are 17 drugs available, such as aspirin, penicillin and others.

Thus, medical students learn pharmacokinetics without the necessity of thorough knowledge of the mathematics, underlying multi-compartimental models.
Rather they learn how to prescribe a drug and how to interpret the results.
When students want to learn more about the principles underlying the physiological processes that determine pharmacokinetic behaviour of drugs, the program gives them the opportunity to design or change their own patient or their own special drug.
For instance the pH of the stomach, intestine or urine, or the body lipids or liver function can be changed. These factors are called patient factors. There are 23 of these patient factors. The same also applies to the drugs in the model. Thus, the student can change for instance the pK or partition coefficient of a drug and so on. There are 43 "drug factors".

In 1978/1979 we used MACDOPE in our department to introduce 20 students to basic pharmacokinetics. We did this on the basis of a number of problems we had formulated and given to the students. With the help of plasmaconcentration-time curves they made the connection between physiological data and concepts like half-life and clearance.

3. Perspectives.

From literature a number of models has been collected in the areas of the cardiovascular system, respiration, pharmacokinetics, enzym kinetics, endocrinology and glucose/ATP system and all these models look very promising for CAI applications. CAI on the basis of simulation of medical systems and processes provides a new and valuable asset to medical learning, stimulating students in problem oriented learning.

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Simulated patients in the Medical Faculty of Maastricht.

Introduction

As the title of this paper states, this article will describe the use of simulated patients in the educational programme of the faculty of medicine in Maastricht. Because medical education by means of simulated patients is an integrated part of our programme, it is important first to explain something about the latter.
In 1974 the medical school of Maastricht became the first of two faculties in the new State University of Limburg.
It was the intention to meet the changing needs of the health care system in the Netherlands by focusing the educational programme on primary health care. Here, preventive medicine, social and psychological determinants of health and disease and multidisciplinary teamwork are intended to play an important role.
Furthermore, it was the intention to meet the changing opinions towards educational principles.
The following 5 educational principles are embodied in the so-called "basic-philosophy" of the faculty of medicine:

1 problem-oriented learning
2 selfdirected learning
3 continuous evaluation

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4 attitude development
5 integration.

1 Problem - oriented learning

Transferring knowledge rather passively to students does not relate to the problem solving abilities required from the future doctor.

For the doctor will first be confronted with patients' complaints, symptoms and problems. With the help of his knowledge, his understanding of basic principles of medicine and his skills, he will decide what area of knowledge is most appropriate to deal with this particular patient.

The starting point for the acquisition of medical knowledge at Maastricht is a case problem or a patient's complaint. The students then discuss during groupsessions the presented problems. Available knowledge is exchanged and hypotheses are identified and discussed. The objective is to try and understand the different processes underlying the problem at hand and formulate the direction of individual learning, after which further group discussions will take place to deepen and broaden the understanding and discuss possible solutions and management.

The opinion is that problem-oriented learning offers more possibilities to develop problem solving abilities as well as to acquire relevant knowledge and offers more possibilities to a multi-disciplinary and integrative approach to medicine and clarify the relevance of the different aspects of knowledge.

2 Self-directed learning

The students are given responsibility for the selection of their own learning activities. For they decide themselves what kind of individual learning is necessary to clarify the presented problems. Learning resources are at their disposal, like a large library, video tapes, films and slides with explanation on tape. A list of content - experts which can be consulted is also at hand. This active exploration of information necessary to get a deeper understanding in medical problems, will give the kind of basic knowledge that is expected to retain its usefulness for a longer period of time than that which a student has received in a more passive way. Furthermore, it is the opinion that a programme that stresses student initiative is a truer reflection of the character of his later career and stimulates the development of independent learning.

3 Continuous evaluation

A system that offers the students freedom in choosing their own learning activities, should also offer the students possibilities to assess their learning progress. Students have an almost constant need for feedback about their learning progress to enable them to plan and select their further learning activities. Therefore continuous evaluation plays an important role in the faculty of medicine of Maastricht.

Each of the first four years of the programme is divided into units of 6 weeks duration. In these so-called "blocks" specific themes are presented to the students by means of the before mentioned health care problems.

During the programme the students have an opportunity for self-evaluation by means of several multiple choice tests inserted in the working book. Towards the end of each programme a so-called "block test" is administered for all students by means of multiple choice questions and patient management problems. The objective is to provide students with quantitative information on the general learning effects of the specific programme-unit. Besides those tests 4 times a year so-called "final test" are administered to all students - regardless of their year of stage - to judge whether individual progress is sufficient to meet the end goals within a given amount of time, which will be at least 6 years. The questions of these final tests cover all major medical disciplines.

4 Attitude development

During the educational process several opportunities are offered to clarify one's own attitude and become aware of the different basic elements of it. The training and developing of a specific attitude is preceeded by an emphasis on awakening and getting hold of one's own attitude.

5 Integration

The drawback of the traditional educational system is that the relationship between different disciplines is usually for students. Every element of our educational program is organised in such a way that integration is possible. This is not only applied to the process of acquiring knowledge but also to the teaching of medical skills in the skillslab. In the skillslab in Maastricht the students can, mostly during the first four years of their medical education, learn the physical examination, nursing, therapeutic, social and laboratory skills that are considered to be necessary for the future "basic-doctor". Simulated patients are used in the skillslab to offer the student opportunities to practice the skills they have learned.

Why and how we use simulated patients

Simulated patients are used extensively within the skillslab and this article will clarify why and how we use them.
A good starting point is probably to explain what we understand by simulated patients.
I would like to quote Howard Barrows - one of the pioneers in the field of medical education by means of simulated patients - to give the definition of a simulated patient.
"A person who has been trained to completely simulate the psy-

chological, emotional, historical and physical manifestations of a patient on observation, interview and examination".

Now, why do we use simulated patients in the medical education of future doctors

The individual doctor-patient relationship shall play an important role in the practice of the future profession of most medical students. Thus, it is essential for every medical educational programme to make the students familiar with their role during these contacts with patients. The use of real patients would cause a lot of problems. Illustration no. 1 shows what happens if many young, undergraduate students enter the hospital to examine patients.
Because of the (un)favourable ratio students/patients, this would mean a heavy burden for the patients.
For patients are surrounded, especially in large teaching hospitals, by many students, clinical clerks, interns, residents and consultants.
Confronting young students with real patients needs close supervision, to minimize possible risks for patients caused by these (still) unexperienced students. These disadvantages are recognised by all faculties of medicine. So students do usually not have, during the first years of their medical education, the opportunities to practise individual student-patient contacts. This results in the pre-clinical years in an isolation of the concepts disease and diseased. This can have serious repercussions as you can see in illustration no 2.

Mostly, teachers only talk and write about the disease and the diseased. But students seldom get the opportunity to experience this entity during the first years of the educational programme.
The simulated patients can bring relief in these circumstances. Although simulated patients can never replace real patients,

they can be helpful to overcome the disadvantages as I named them and they offer several extra advantages.

Students can learn, by "trial and error" without any risk for the simulated patients involved, for instance to take the medical history or to diagnose neck rigidity.

Another advantage is that by means of simulated-patient contacts the relation between the medical training of students and their future professional work is strengthened. This can cause an extra motivation for students.

The supervision is not necessarily preoccupied with the risk for the actual simulated patient but concerns itself primarily with the educational needs of students.

There are several extra advantages. Simulated-patient contacts can be repeated as frequently as needed. This guarantees similar experiences for all students. Disease-courses can be presented in one simulated patient contact by giving for instance information about operations, hospital admission, X-ray examinations, etc. to the students during simulation sessions.

Last but not least, with simulated patients we can focus on those diseases which are rare in large hospitals. In this way we can avoid the selective morbidity pattern of large teaching hospitals.

Of course there are disadvantages.

For instance some signs and symptoms are impossible to simulate. Heart murmurs and pulmonary rates are only a few examples. But with certain audiovisual aids that is easy to overcome.

Another disadvantage is that some students have difficulty in accepting the simulated patient as an educational appliance. In our experience only very few students show this attitude.

After this brief summary of the educational advantages and disadvantages of simulated patients, I would like to return to the already cited educational principles of our faculty of medicine.

It will be clear by now, that the simulated patients greatly stimulate problem-oriented learning.

By means of well-trained simulated patients health care problems are presented to students. The student tries to clarify the presented problem by means of a proper interview and examination and formulates the direction of the possible solution(s) and management. Evaluation of the simulated patient contacts will show the level of knowledge, skills and attitude of the students.

Finally, the simulated-patient contact offers an opportunity within the skillslab to practise knowledge and skills integrated in their attitude. We can conclude that simulated patients are widely used during the first 4 years of the medical curriculum because this has definite educational advantages, which link up very well with problem oriented learning, self directed learning, evaluation and integration of knowledge, skills and attitude.

Now that the question why we use simulated patients has been clarified I would like to come to the matter of how we do that. The skillslab programme in each unit is centered around the programme unit themes.

I shall give an example.

Programme unit theme: Bloodloss

no : 3.5
time 12th March - 27th April 1979 (6 weeks)
programme skillslab:
physical examination and therapeutic skills:

- examination ear, nose and throat
- examination abdomen
- gynaecological examination
- first aid and suturing
- bandaging

laboratory skills

- examination of faeces, sputum and urine for blood
- bloodgrouping
- Hb, Ht.

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- truth telling session

Simulated patients contacts

- Woman with vaginal bloodloss during the use of oral contraceptives (spotting)
- male with rectal bloodloss, probably due to carcinoma of the colon.

The integration of all elements of the central theme is given great priority. One can see that there are two simulated patient contacts in each programme unit. This goes for every programme unit of the second, third and fourth years of the curriculum. We think that this is the minimum to create continuity in this respect.

During those contacts one student gets the opportunity for about 45 minutes to clarify the patient's problem by means of an interview and examination and to search, together with the patient, for possible solutions.

Another student is present as an observer.

In the first year of the curriculum the simulated patients programme looks somewhat different. We introduce the concept of simulated patients in several role plays. One student plays the role of a doctor and another student the role of a patient in a group of about 8 students guided by a faculty member who is experienced in this respect. Later on a "real" simulated patient comes into the group. One student does the interview and discusses the patient's problem with the group. This time the tutor guides and stimulates the group in the learning process of this student - simulated patient contact.

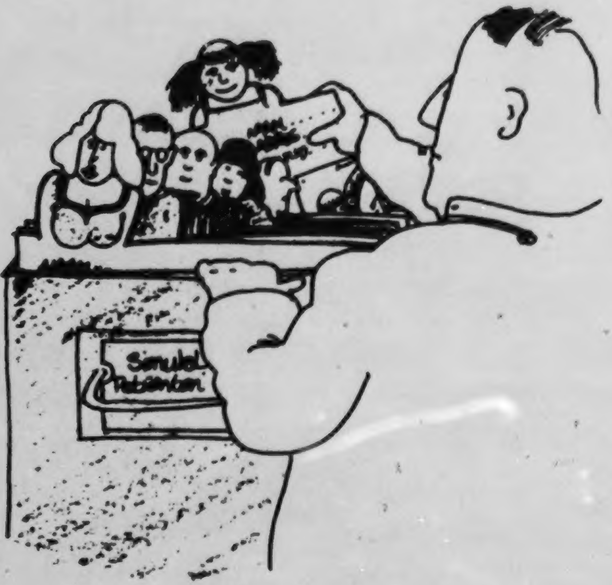
In this way the students become familiar with interviewing patients within a group, whose members can always be consulted. In later programme units the groups are divided into two groups of 4 students. Finally in the last unit one student has an individual contact with a simulated patient, while only one other student is present as observer. We have organised the simulation sessions in the first year in such a way that students become familiar with simulated patients step by step.

This is essential for very young students to create a comfortable and responsible environment in which contact with simulated patients can have a profitable learning effect.
At the end of the third and fourth years of the curriculum we organise a simulated doctor's office.
Four different simulated patients, whose problems have no relationship with the programme unit of that period, are seen within one hour by one student. We do this because at this time we may expect that the students are so experienced in talking with and examining simulated patients, that they are able to work under the pressure of time and with unexpected problems.
After four years the students have experience in working with simulated patients. They have attended or participated in the following activities:
3 simulated patient role plays (attended/participated)
4 simulated patients in the group (attended/participated)
14 individual simulated patient contacts (participated)
14 individual simulated patient contacts (observed)
2 simulated offices with a total of 8 simulated patients (participated).
These experiences will give them self confidence to work with real patients and to interview and examine them skillfully.

Selection and training of simulated patients

For the selection of our simulated patients we do not use any professional actors but people from the general population of Maastricht and surroundings. After an informative article in the local newspaper we interviewed 400 applicants and selected approximately 70 persons. Two of the selection criteria used were:
1 Interest in and motivation for the participation in the education of medical students; and 2 the ability to give feedback to students about the student-simulated patient contact.

Also people's flair and improvisation ability was taken into account. We now have a pool of simulated patients to choose from, as illustration no 3 shows.



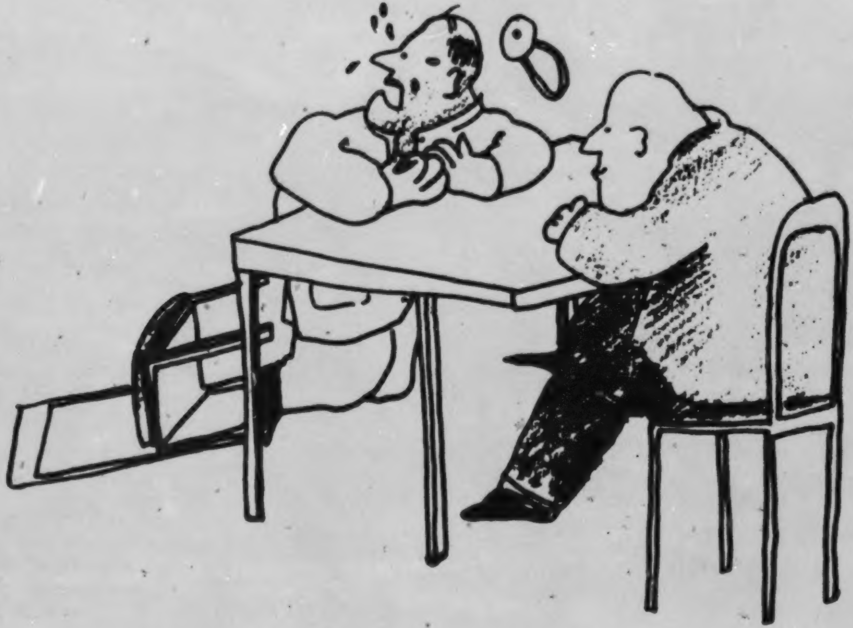
The roles for the simulated patients are dependent on the needs of the theme of the programme unit and the objectives of the skillslab.

Together with the planning group for the programme unit we decide what role is appropriate.From our pool of simulated patients we chose 4 persons who, according to age, sex and personal characteristics, are capable of playing that specific role.

Those 4 persons read the script of the role and then come to the skillslab for a collective training. We start with a general discussion about the role they are supposed to play.

Can it be played? does it need any changes? additions? or clarification?

We talk about the emotional aspects of the role. Then we concentrate on the physical signs and symptoms. As you can see in illustration no 4 we do not fear to participate fully in demonstrating signs and symptoms.

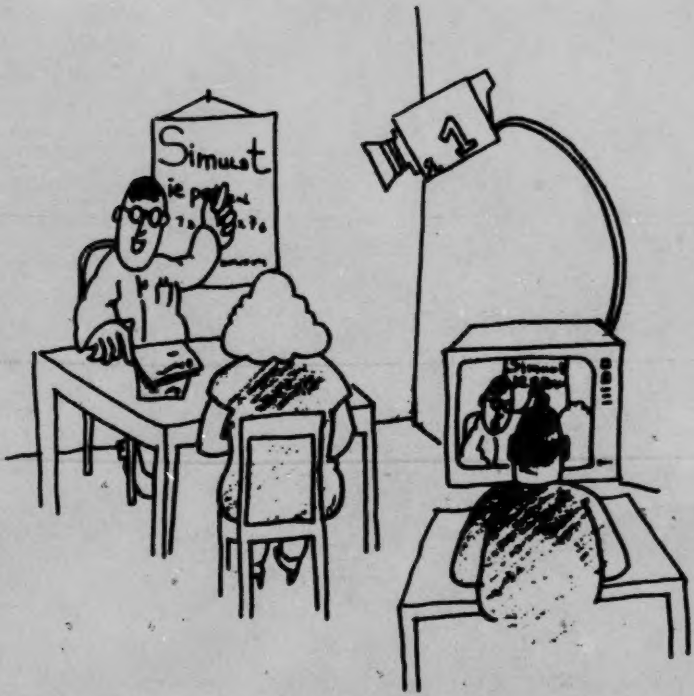


Finally we decide if the patients are ready to simulate. The simulation is simulated! A member of the skillslab staff plays the role of a student and observes if the simulated patient is completely familiar with his role. We ensure that the simulated patient is able to give his information in appropriate "dosage" and we check his ability to improvise on unexpected questions from the "student".
A second training is giving, if necessary. The simulated patients return a few days after the last training to participate in the actual simulation session with students. In the meantime the simulated patient's family doctor is informed about the role his patient will play. Of course with the consent of the simulated patient.
Up till now, unfortunately, one simulated patient had to consult his own general practitioner afterwards with complaints similar to those in his role. This made us even more aware to be scrupulous in the selection of our simulated patients.

The simulation sessions

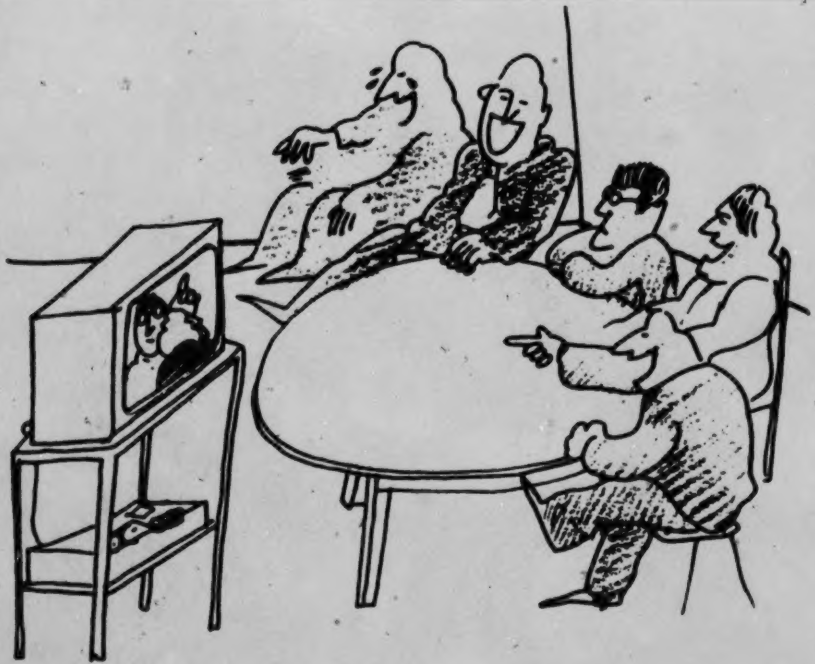
You see in illustration no 5 the student, the simulated patient and the observer, also a student. The examination table and the necessary examination instruments are not shown. The whole session is recorded on a video tape. A television set shows live the student and the simulated patient encounter. The student and the observer are paired for 1 year during all simulation sessions. Every simulation session they change roles. The observer's job is to give immediate feedback after the simulation session and to be available for consultation during the sessions.
After the interview and the examination the video tape recording is stopped and the 2 students sit together with the simulated patient for the first assessment. They try to assess the quality of the student-patient contact. They focus primarily on the student's attitude and not so much on his medical know-

ledge and skills.



Did the simulated patient have an opportunity to present his problems sufficiently? Did the student understand the patient? If necessary part of the video tape can be replayed. In this way the student gets appropriate feedback about the quality of his contact with the simulated patient.
For the best feedback in this matter is given by the person who is in the role of the patient.

After his first assessment the student as well as the simulated patient fill a form with questions about the quality of the contact. The student fills another form, where he states the signs and symptoms of the simulated patient and tries to come to a diagnosis. Those forms are taken to the second assessment a few days later. Groups of 4 students pairs come together with a physician and a faculty member who is an expert in communication. During this evaluation those aspects are discussed that are felt relevant to the group. We try to train those supervisors to focus in the first two years mainly on the communicative aspect of the student - patient contacts. In the 3rd and 4th years they also focus on the medical aspects.



Thus a learning situation is created to make the students conscious of their knowledge, skills and attitudes, in their functioning with patients. How this group should not be functioning is shown in illustration no 6. It is obvious that this student is not in the perfect learning situation, but only feels miserable.

At the end of the 2nd assessment meeting, the group supplies us with information about the role of the simulated patient. This information can be used to decide on further simulations.

Conclusion

This paper intends to give a global impression of why and how simulated patients are used so widely in our curriculum. All is still in an initial stage and we hope to improve many aspects of it. We are critical about our own efforts, but we are firmly convinced that simulated patients contacts form a useful contribution to the medical education of students. Furthermore, we realise that the educational possibilities with simulated patients are far from exhausted. Last but not least, we hope that through simulated patient contacts students realize and will continue to realize during their professional careers, that patients are not living diseases, but human beings who happen to be ill.

5.4 In urban planning.

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Some problem dimensions of urban game design.

1. The use of games.

It is generally accepted that there are three major areas in which games can be used to advantage, Planning or Decision-making, Research and Education.
Games intended for planning tend to place emphasis on system simulation. In this way, policy bundles or strategies may be tested for their effectiveness as evidenced by the directions in which the system develops, and appropriate planning choices made. The integration of simulation, usually computer-assisted, into the game makes it serve as a useful tool that can easily fit into many stages of the planning process. Thus, in addition to the obvious role of projecting the future trajectory of the system, the game can also be used to test for sequential decisions or choices that many appear to be sub-optimal at first glance but in effect may be the best both in terms of the uncertainities present as well as the limits posed by other decision-makers.
Games used as research tools on the other hand make their major contribution in system analysis. Strict emphasis has to be placed on the game structure.

Since it has to serve as a vehicle for testing hypotheses and formulation of theories, the internal consistencies and rigour are of prime importance. It is not surprising therefore that many games of this category exist 'on paper' only. Usually they are stated in the 'normal' (mathematically abstract) as opposed to the 'extensive' (particular) form, (Schelling, 1960, Harsanyi, 1977). Whereas the above categorisation may not be universally accepted there are times when the differentiation is important. Schlenker and Bonoma, for example, have made the distinction between games, which they state are 'hypothetico-deductive experiments and simulations, which are studies performed on a coherent theoretical model. This distinction is considered by them to be essential for the analysis of the validity of the results (Schlenker and Bonoma, 1978).

Games for educational purpose pose an entirely different problem. In a sense they have to be both a model of some reality to be studied (or taught) as well as a tool for manipulating the system. In addition, they have to have other somewhat nebulous properties that make the learning experience enjoyable and thus to increase its attractiveness as a teaching tool.
In particular the problem is compounded when the system to be studied is a planning system. As we shall see later, a game of a planning system that is in itself a planning game poses an interesting design problem.

This paper describes some lessons learnt in devising such a game. The objective was to construct a game in order to teach students at the undergraduate as well as graduate level, the structure and dynamics of the Israeli planning system.*

* Law-Yone, 1979.

2. The requirements of a learning game.

In order to devise a game whose major purpose is to facilitate the learning process the first step was to review some of the major steps by which learning takes place. To put it in a nutshell, it begins by a consideration of factual data or phenomena. Induction enables progressive abstraction and theoretical generalisations, and, by deduction, predictions are made which are tested in the real world. It is generally accepted that this dual deductive/ inductive process gives rise to understanding. Two more factors might be mentioned as contributing to the enhancement of learning viz., the subject must be interesting enough so that the student wants to learn and the process itself must be enjoyable enough so that the necessarily repetitive acts are willingly undertaken.

Based on these premises, the goals of the game can be defined:

1. It must be based on factual data or concrete phenomena.
2. The structure and parameters and relationships within the game must be based on theories and hypotheses, and these in turn must be capable of being induced from the data.
3. The form and nature of the game must be such that predictions made on the basis of hypotheses should be capable of being tested. This involves being able to simulate the consequences of the manipulation of certain variables.
4. The game should be interesting to a variety of different personalities.
   It should be flexible enough so that different styles of action can be accommodated equally well.

5. Playing the game should be an enjoyable experience. The criterion proposed to test for this goal is to determine if there is willingness to play the game time and again.

Bearing these goals in mind, an urban planning game (MATA) was devised and played over several semesters. The game underwent many transformations and adjustments based on the comments and lessons gained from each session. Although its present form is far from final, it is possible to make some tentative observations on the nature of the major problems encountered in game design.

3. Some problem dimensions.

The following are some contributory factors in determining the success or failure of an educational urban game, as experienced in the development of MATA, together with the ways in which corrections have been attempted.

3.1 Focus.

This problem is that of deciding at which level the system is to be modelled.
The larger, more comprehensive, the system is, the less detail is possible in presenting the consequences of joint decisions. One has to compromise therefore between the desire to present a holistic view, and the need to know with some accuracy the consequences of your actions. Furthermore, even once such a compromise is achieved a fixed focus approach can be limiting. Induction and deduction both involve a change of focus, without necessarily altering the boundaries of the system.

This problem was taken into account in MATA by devising it in hierarchical form.

The game can be played at several levels, each level differing in the detail of options and interactions. Combinations between several levels are also possible. Thus, focus can be changed, even in the middle of the game.

3.2 Flexibility.

Games usually have a rich network of inter-connections. Hence changing a parameter or an outcome can have a chain of repercussions that is difficult to control. The heuristic function of a game should, however, permit a player to try things differently, i.e., not only to try out different strategies but also change the conditions of decisions. This flexibility of a game that permits manipulation without changing the game itself, is an important quality.

In general, flexibility is related to the richness and complexities of the interrelations. Simply put, the most flexible game is the one with the least structure. Such a game may have heuristic value and may be interesting up to a point. However, it departs from reality in that interdependencies and constraints are part of life without which the game runs the risk of turning into a fantasy.

Flexibility is introduced into MATA by giving it a basic structure within which both rules and outcomes can be changed (within set limits).

3.3 Variety.

There are some indications that the capturing of interest in a game is related to the degree of unexpectedness of the events that occur. This element of surprise in turn, seems to be related to the range of choices open to the players.

The greater the number of optional plays open to a player, the more variety there is in each play. Borrowing concepts from cybernetics it may be possible to use a measure of the variety or information in the game as an indicator of the level of surprise in it.*

On the other hand, simply increasing the variety of a game will not do. There is ample evidence that interest flags very quickly for games of pure chance.

At the other end of the continuum, games with a very limited number of options are also notorious for generating only one time interest.

This problem is not entirely solved in MATA. It was found that there was considerable interaction between variety and the other problems of focus and flexibility. Thus although an attempt was made to maximise variety by providing add-on options of choices and outcomes, the element of surprise present varied from level to level at which the game was played.

3.4 Time.

This is one of the key dimensions of the game design problem. There are in fact two facets to the problem; the scaling of time and the flow of time.

Scaling down, or compression of time happens to be a necessary property of a game. The degree of scaling down or the correspondence between game time and real time is, however, not critical. The relationships may be found by trial and error, a base variable from the game may be chosen as a determining factor, or the ratio may even be left to 'float'.

The flow of time, on the other hand, is critical.

It is a common feature of urban games that they are played in steps (in which decisions are coordinated to represent simultaneity), several steps constituting a round, and rounds being recycled throughout the game. The discountinuity in time introduced by this device detracts seriously from the illusion of realism. Time, it said, waits for no one. The inability to stop the clock forces one to decide without all the information at one's diposal. In game theoretic terms, we have players playing with incomplete and imperfect information.

Furthermore, the flow of time is of significance in another sense. The timing of decisions in urban development is ofter to crucial importance. The consequences of a particular sequence of decisions in time are fundamentally different than if the same decisions were made in another sequence.

For these reasons, the flow of time should be kept as uninterrupted as possible.
On the other hand, learning the game may require clarificatory time-outs and backtracking.

MATA has been made very time-conscious. There is a clock on the wall visible at all times. There are no steps or rounds. Time scale is decided beforehand and may be changed later on. There are absolutely no time-outs except for discussions at the end of a session. In this way, the players play not only against each other but also against time.

3.5 Ideology.

Urban planning, whether in a capitalist economy or a mixed economy, is intimately related to ideology.

The institutions, procedures and style of urban planning is extremely sensitive to the ideological milieu. It has been found that games based on a 'free market' type of urban development are not suited to a regulated system such as Israel's where there is strong centralised control over the use of land. If the impact of ideological frameworks is to be examined, the manner and degree of regulation should be made parameters in the game.

Ideology also has an impact at the player level. It has been found that the motivations of the players are often mixed. While it may be true that a purely competitive "Spirit of Capitalism" is a necessary moving force behind such games as CLUG (Lundgren and Loar, 1976), players who value the achievement of common goals by means of cooperation and mutual aid should have a built-in framework in which to do so. Finally, ideology comes into play when the amount of intervention necessary has to be decided on. Obviously, intervention should be minimised during the game run. The question arises, however, whether intervention is necessary to prevent cheating. Is a certain amount of cheating part of the game with its counterpart in reality? This question becomes pertinent under conditions of large scale illegal building such as currently characterising the Israeli scene (Alterman and Law-Yone, 1979).

MATA, the game in its present form, is based on the existing Israeli system which is essentially a positive, regulatory system. The game is constructed, however, such that these frameworks can be relaxed, tightened up, or even dismantled. Cooperation, as well as competition is possible, the results of which are easily observable in the outcomes of interaction between the groups.

The question of intervention has been left open. If and when cheating, or circumvention of the system, assumes major proportions, this is a serious matter that has to be solved within the context of the game.

4. Concluding remarks.

The basic requirements in the properties of a learning tool place heavy demands on an educational game. In addition to being a framework that allows conceptual induction/deduction analyses, and one that produces consistently accurate trajectories for different decision strategies, it has to possess that elusive but essential element of a learning game, enjoyment.

It is suggested that interest and enjoyment, beyond one's subjective personality traits, are intricately bound up with the way in which these five problems of focus, flexibility, variety, time and ideology are dealt with.

Our experience with game design is still at a very primitive level. It is a fact that even though we are all 'homo ludens' for most of our lives, in all honesty we must confess that we still do not know with certainty what makes a game, in the final analysis, intellectually stimulating, interesting and - fun to play!

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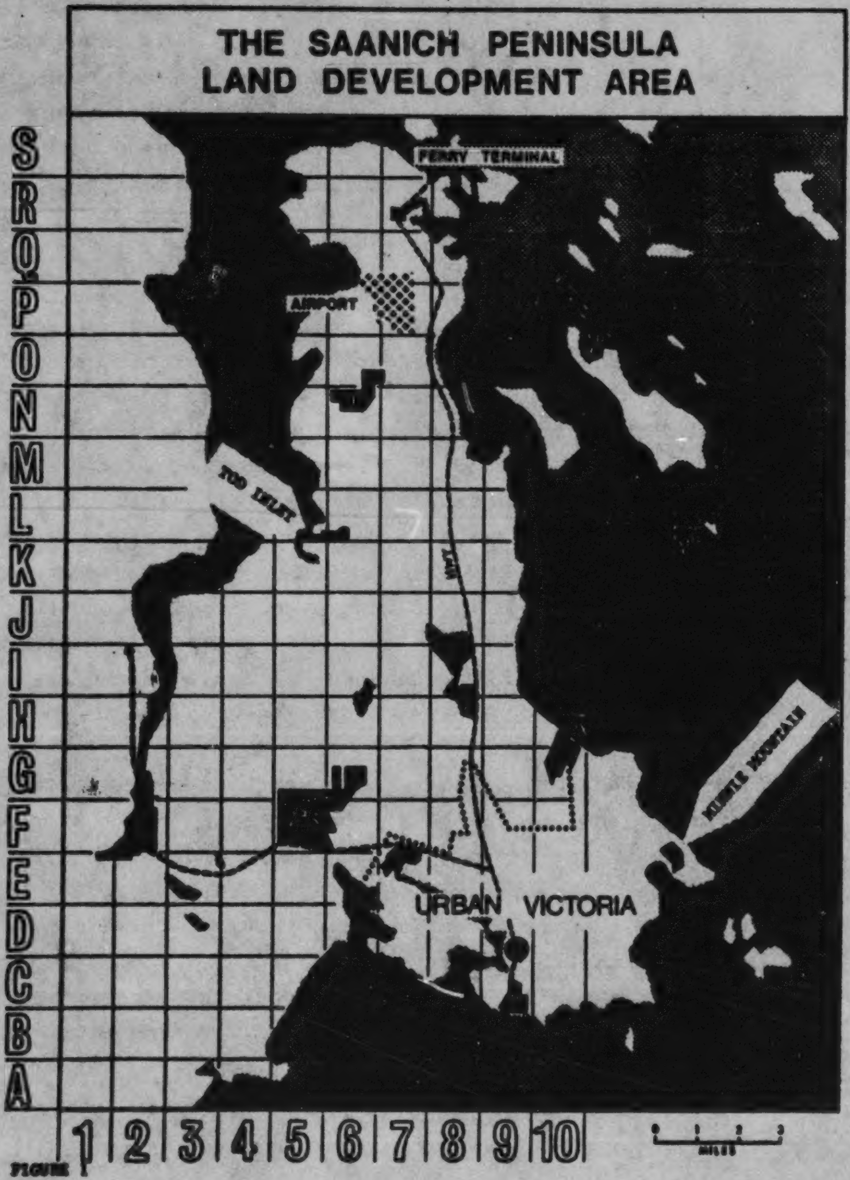
5.4.2 Dr. Colin J. B. Wood, Department of Geography, University of Victoria, British Columbia, Canada.

The Saanich land use game: Abstract and reality.

1. Land Use Competition.

The patterns of land use which we observe in urban and rural areas are the result of a complex interplay between market forces, political and social behaviours and the variations in the natural physical environment. A substantial body of theory in economics, geography, regional science and planning has been developed which explains the arrangements we see around us. However, there are limitations to this conceptualization of land use in that the modelling techniques are predominantly normative and structural and give little insight into the non-optimizer, "Satisfying" decisionmaking processes involved.

Partly as a response to the inadequacies of this conceptual approach and partly to get a better understanding or 'feel' for the myriad of social and environmental processes which lead to land use arrangements several simulation models of land use process have been developed. (e.g. C.L.U.G. etc.). This paper describes the structure and operational procedures of a simulation game which has been developed to help understand the land use patterns of the Victoria Metropolitan Region of British Columbia.


THE SAANICH PENINSULA
LAND DEVELOPMENT AREA
FERRY TERMINAL
AIRPORT
TOD INLET
URBAN VICTORIA
S
R
Q
P
O
N
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A
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MILES

FIGURE 1

A common criticism of simulation games is that they themselves as abstractions, can rarely be compared to the processes they model (the simulandum). In this paper, an attempt will be made to show that in many land use developments in the Victoria Region the participants behave as if it were a game. Consequently it is argued the simulation game is much closer to reality that most people realize.

2. The Saanich Game.

Metropolitan Victoria is a growing city region on the soutern tip of Vancouver Island, British Columbia. With a population of about a quarter of a million and a varied economic base founded on forest products, tourism and government (the Provincial capital) it has experienced considerable expansion in recent years. This growth has created a demand for land use change from rural to suburban and urban-industrial. As a result, land use conflict and a perceived need to develop guidelines for future development exist. The Saanich peninsula is the area where most of these changes have taken place.

The Saanich Land Use Game[1] endevours to simulate the process of land use change by abstracting a more manageable version of the macro land use change process. Players assume the roles of macro decisionmakers, government, real estate, industry and endevour to achieve certain predetermined goals. This entails bidding for land for development, managing a cash and capital account and coordinating activities within the group. The simulation is complete where a certain number of cycles of land development activity have been reached.

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[1] Wood, C.J.B. Handbook of Geographical Games: Western Geographical Series, vol 7; (1973).

From a real life (simulandum) of several thousand parcels of land, the game is an abstraction of approximately 150 (Figure 1). From a total of over two hundred groups actively involved in the land use change process the game is an abstraction with four groups involved: furthermore, the simulation accelerates the process so that the changes occurring over several decades are compressed to a few hours.

This simulation game has been used for almost ten years as a teaching model to demonstrate not only the general process of land use change but also to illustrate more specific characteristics such as rising land prices, conflict over coastal property and the impact of major infrastructure change (roads and utilities). An important specification in the simulation's operating procedure is the determination of the geographical scale at which the game is to be played ranging from local micro to macro regional.

3. Real games.

The simulation is an abstraction, how relevant is this portrayal of reality? An answer to this basic question is found by examining how growth has actually taken place in the Greater Victoria Region. While there is not an exact duplication or parallel it is suggested that there have been some recent developments which are themselves gaming activities, so that the real-life situation is much more closely modelled by the gaming simulation that is realized.

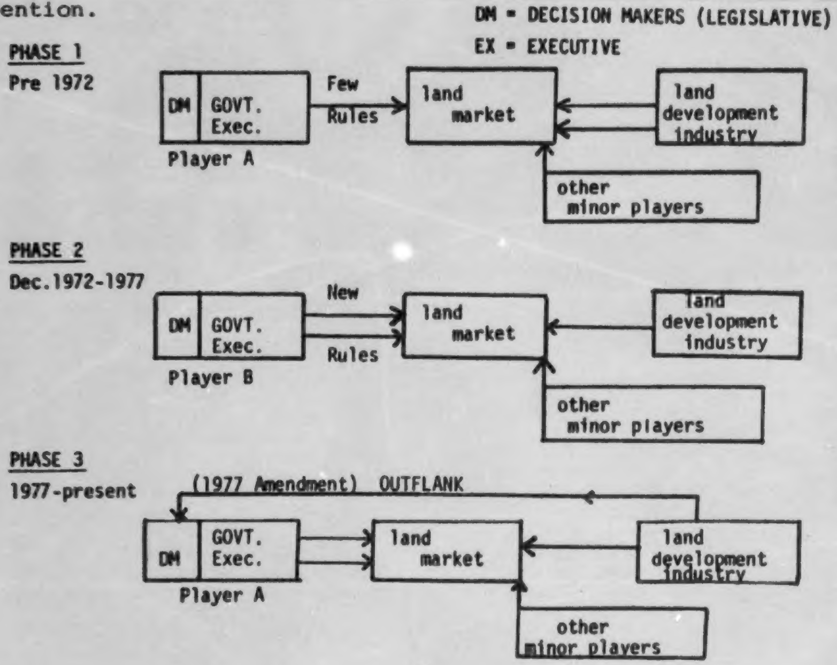
To illustrate this argument examples will be drawn from a regional 'macro' perspective and a local micro scale.

It is necessary to note that the land use legislation, which we may interpret as 'the rules of the game', is a Provincial jurisdiction within the legislative framework of Canada's Federal/Provincial system.
Furthermore, land use decisions at the local level are a municipal concern, but the municipality derives its jurisdiction from the Province.

Regional games: At the level of aggregated land use activities, or the regional scale it is suggested that there are two basic players in the region concerned.

(1) government: (2) real estate and land development industry:

Until late in 1972 they have interacted in a "free market" system with a general minimum of government intervention.


DM = DECISION MAKERS (LEGISLATIVE)
EX = EXECUTIVE
PHASE 1
Pre 1972
DM
GOVT. Exec.
Player A
Few
Rules
land market
land development industry
other minor players
PHASE 2
Dec.1972-1977
DM
GOVT. Exec.
Player B
New
Rules
land market
land development industry
other minor players
PHASE 3
1977-present
(1977 Amendment) OUTFLANK
DM
GOVT. Exec.
Player A
land market
land development industry
other minor players

A dramatic change in Provincial government from a conservative to a mildly socialist one saw many new measures, a freeze placed on the sale of all agricultural land for non-agricultural use and the eventual enactment of an executive body to deal with land protection[2].
This strategy for implementing social priorities in land development resulted in tremendous argument particularly with property investors, speculators and the land development industry. However, despite the use of pressuring and threatening tactics, from both the industry and the old government now in opposition (the latter being fairly closely identified with the land development industry) the legislation remained unchanged.

The outcome of the next Provincial election (1975) saw a return of the political party who had previously held power. However, they did not dismantle the agricultural land reserves, as the land now zoned for protection and withheld from development came to be called.
Instead, the legislation was amended so that parties wishing to have property excluded from the reserves could appeal directly to the minister and thus, in a sense outflank the executive machinery erected by the phase 2 government. Consequently, agriculture land is now under pressure again for development.

This game playing between major participants in the land development process in British Columbia is still in a fluid state.
Another election in 1979 saw the Phase 3 government returned to power but only by a narrow margin. Repeated attempts to have land excluded from the agricultural land reserves by the development industry has led to considerable public outcry to the extent that the 'outflanking' strategy in under pressure.

The contest between the land development industry, who want a minimum of government interference, with the government, who can be either a "non-starter" or a player actively and positively involved in the land development game, is an interesting illustration of a "contest" played at the regional geographical scale. This aggregated scale of decisions has been parallelled by a series of land developments games at the local scale between individual municipalities and development companies.

Local games:

The municipalities work within the jurisdiction of the Province, so that the agricultural land reserves, for example, were imposed upon them from above. However, they nevertheless have power and authority to control development through a permit system. Two major proposals have been aired in the region which are indicative of the local level of gaming activity.

(1) Central Saanich: Proposed development at Tod Inlet:

Figure 1 shows the proposed development at Tod Inlet in Central Saanich. Genstar, a multinational, European-based conglomerate is advocating a multipurpose residential and commercial development. They put forward their plans and indicated the benefits which would accrue to the local municipality, increased tax load, availability of water from a new water main to name two.
Local citizens reacted negatively to the scheme arguing that the development would spoil the area, which includes an internationally known flower garden, opening up the way for even more urban growth. Furthermore people argued that the company were only going to

develop the land not actually do the designs and construction of buildings.

The municipality, who organized public meetings to discuss the plans, have been in a dilemna. If they allowed the development to go ahead it would be contrary to the pattern of development envisaged in the community plan. However, they could not stop a development which met the local zoning requirements.

To effect a decision from the council both sides, the developers and the general public have used tactics to influence the municipal council to reach a decision favourable to their viewpoint. The developers arrived at meetings with an array of information which showed the benefits of the project. Conversely, local citizens who felt threatened by the scheme reacted vociferously to the council and some even advocated civil disobedience: they relied on the sheer volume of opposition to make itself felt with the council. This turned out to be effective because the council rejected the company's plans. (Spring 1978).

However, subsequent to this decision the company went away, revamped their plan and approached council again. This time with several amendments including the offer of some land to be given to the council as a waterfront park. It was on the development of this particular area (22 acres) that most of the public had voiced their opposition. Despite the modification to the proposal, the local municipality again decided to prevent development going ahead and endorsed a development plan which zoned most of the proposed area (Genstar property) as recreational land.

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Minnie Mountain. A second micro scale or local game concerning land development in the region is the conflict or gaming over the proposal by Broadmead Farms to develop the Minnie Mountain area. (Figure 1).
Structurally, it is similar to the previous example, with the participants being:

(1) a development company
(2) opposed local residents
(3) a local municipality who grant a development permit (Saanich).

Broadmead Farms approached the municipal council in 1978 for permission to develop 30 hectares of land in the Ten Mile Point area of Gorden Head. The plan incorporates single and multiple family dwellings. A group of local residents who are opposed to the scheme attempted to persuade council not to allow the plan to proceed.

A by-law to permit development was given approval in October, 1978: the coucil's decision was reached by a majority of one vote, after a public hearing on the issue.

A residents' association which was formed to oppose the proposed scheme, launched a civil suit arguing that council had acted improperly.
They levelled their attack at one of the Aldermen arguing that it was improper for him to vote on the issue and the same time be an employee of the law firm which put forward the proposal for the development company. Consequently, in a civil suit before the B.C. Supreme Court brought against the municipality by the citizens' group the judge ruled that a conflict of interest did exist: the by-law was quashed thus preventing the plan's implementation (Dec. 1978).

However, the municipality, acting under the direction of the mayor decided to appeal the decision, arguing that the judgement would set a constraining influence in local municipal representation. In the appeal, the Supreme Court overturned the earlier ruling. Despite the sudden reversal the issue is far from resolved and the citizens group are contemplating further action.

Overview.

Land use change is an area of human activity that has been the concern of academics, government, business and the general public.

The land use we see around us is the end product of a multiplicity of complex decisions which simulations can help us to understand. Yet these simulations are not mere abstractions for the processes of human activities and interactions which create the phenomena we see on the landscape exhibit all the characteristics of games themselves rather than the operations of a simple market mechanism. Crucial decisions hinge on players adopting suitable strategies and tactics; participants have to organize and marshall support in order to attain their goals. Chance events and changing public preferences can alter the rules of the game and the powers of the umpires. Whether land is developed depends on ownership, access, availability of utilities, financing and the particular voting preferences of the municipal council.

5.5 In science education

5.5.1 Dr. E. Addinall, dr. H. I. Ellington, mr. F. Percival and mr. M. E. Smythe, Robert Gordon's Institute of Technology, Aberdeen, Scotland.

Designing science-based simulation games - a systems approach.

Introduction.

During the last five years, the authors have been involved in the development of a large number of science-based educational games designed for use at both school and college level. Despite the widely-differing character of these games, however, it has been possible to adopt a single underlying rationale, based on a systems approach, to their design, development and exploitation.

A short review of this rationale was previously published in SAGSET Journal (Ellington and Addinall, 1977a). However, in view of the principal theme of the 1979 ISAGA Conference - 'How to Build a Simulation/Game' - it was decided that a more detailed and up-to-date paper should be written on the subject as it was felt that such a paper would be of considerable interest to delegates, particularly those who would be meeting simulation/games for the first time.

The authors believe that the type of systems approach that they have employed is applicable to the development of virtually all types of games and simulations, and not merely to science-based exercises of the type with which they have been principally involved.

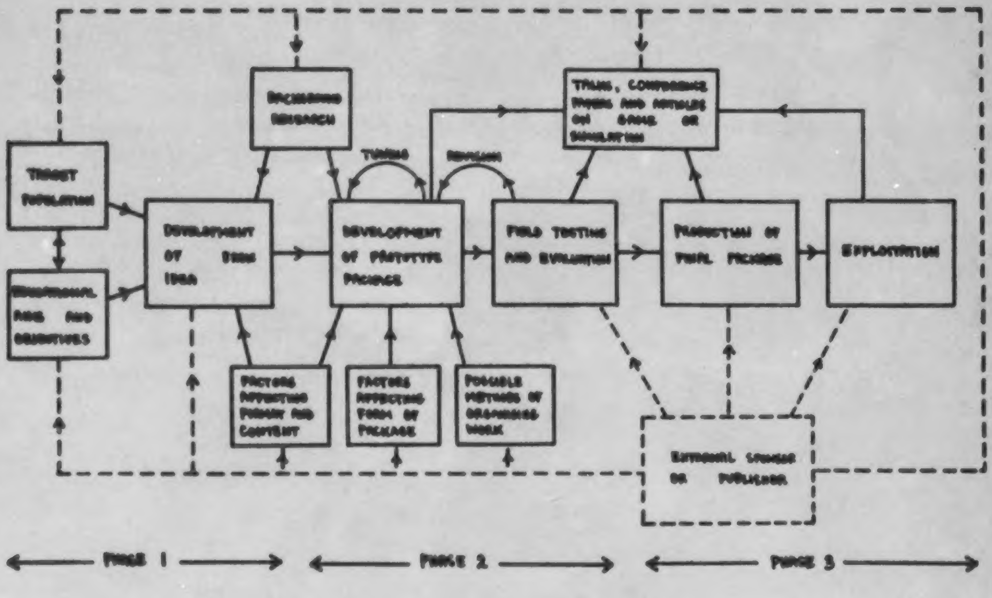
Summery of Rationale.

The development of any educational game or simulation falls naturally into three distinct phases (see figure 1). The first of these is the development of the basic idea. The second is the cyclical process by which a viable educational package is developed and eveluated. (This is generally the longest phase.)
The third is the production and exploitation of the final package.

One factor that can exert considerable influence on any or all of the three phases is the existence of an external sponsor or publisher. The experience of the authors has been that such an 'external presence' is extremely helpful during the course of the development of a game, and is of crucial importance during its final production and exploitation. Indeed, without an external sponsor or publisher, it would be extremely unlikely that this final phase would ever be reached in most cases.

The authors are fortunate in that the U.K.-based Institution of Electrical Engineers (I.E.E.) has taken an active interest in virtually all their games. The I.E.E. has helped both with the development of these games and with their publication and promotion. To date, six such games have been published by the I.E.E. and several more are in an advanced state of development.

FIGURE 1


TARGET POPULATION
EDUCATIONAL AIMS AND OBJECTIVES
DEVELOPMENT OF BASIC IDEA
BACKGROUND RESEARCH
TRIALS
REVISION
DEVELOPMENT OF PROTOTYPE PACKAGE
FIELD TESTING AND EVALUATION
PRODUCTION OF FINAL PACKAGE
EXPLOITATION
TALKS, CONFERENCE PAPERS AND ARTICLES ON GAME OR SIMULATION
FACTORS AFFECTING FORMAT AND CONTENT
FACTORS AFFECTING FORM OF PACKAGE
POSSIBLE METHODS OF ORGANISING WORK
EXTERNAL SPONSOR OR PUBLISHER
PHASE 1
PHASE 2
PHASE 3

Phase 1 Development of a basic idea.

The basic idea for an educational game or simulation should (ideally) arise from the identification of a gap in the educational curriculum or in existing training programmes and the realisation that an appropriate game or simulation would be an effective means of filling this gap. Specially, it is necessary to relate one's basic ideas regarding possible format and content to the desired target population and educational aims and objectives (see figure 1). A considerable amount of preliminary background research may be necessary at this stage.

In the experience of the authors, the initial idea that stimulate the development of a game or simulation very often comes from an external source, and the skill of the successful 'gamester' lies in being able to decide which of the many such ideas with which he is confronted are capable of being developed into worthwhile games.

Consider for example two of the games that have been published by the IEE - 'The Power Station Game' and 'Hydropower'. The idea for the first of these games originated with the Scottish Education Department, who wanted a large-scale physics-based exercise for use with senior pupils in Scottish secondary schools in the comparatively slack period following the end of the 'Higher Grade' examinations. Following an approach to Robert Gordon's Institute of Technology (RGIT) in 1973, the idea of producing a decision-making exercise based on the choice of type and siting of a large power station was developed (Ellington, Langton and Smythe, 1977).

In the case of 'Hydropower', the original idea came from the North of Scotland Hydroelectric Board, who:

a) wanted to organize a competition for Scottish Secondary Schools as a follow-up to a highly successful Primary School competition that had just been completed and
b) wanted to arouse public interest and awareness in hydroelectric pumped storage, since such schemes were likely to play a large part in their future plans.

In 1976, 'Hydroboard' (as it is often called) asked two of the authors to develop a competition package based on the design of a hydroelectric pumped storage scheme (Addinal and Ellington, 1978). Following the successful completion of the competition, the exercise was eventually published as 'Hydropower' - a multi-disciplinary multi-project pack. The package consist of a series of six projects based on the central theme of the design of a pumped storage scheme. Each project represents an in-depth study of one or more of the different aspects of this type of large technological development, and the package as a whole provides a source of realistic case studies in a variety of disciplines - e.g. geography, economics, environmental studies, physics and engineering (Ellington and Addinall, 1977b).

In both cases, it was necessary to carry out a considerable amount of preliminary research before work on the design of the package could even be started. In the case of 'The Power Station Game', the development team (a group of Aberdeen teachers, lecturers and educational administrators led by Professor Norman Langton of RGIT) wrote to bodies such as the Central Electricity Generating Board, the United Kingdom Atomic Energy Authority and the National Coal Board for detailed information about the different types of Power Stations and fuels. Before starting on 'Hydropower', the two authors made several trips to the Hydroboard's Edinburgh Headquarters for technical discussions with the chief engineer in charge of its pumped storage projects and then made a three-day tour of Scottish hydroelectric schemes. The authors are convinced that rigorous background research of this type is an essential prerequisite to the development of a realistic and meaningful exercise.

Phase 2 Development of an Educational Package.

The development of the original basic idea for a game or simulation into a viable educational package is perhaps the most difficult and certainly the most complex and time-consuming of the three phases. The iterative nature of the development process and the large number of factors which have to be taken into account are illustrated in figure 1. Essentially, the process is one of developing, tuning, testing, evaluating and revising the package until one is satisfied that it meets its design criteria. Depending on the specific nature of the game or simulation, the complete process can require anything from a few weeks to many months.

In the case of 'The Power Station Game' (admittedly an exceptionally large-scale and complex exercise), the process lasted over two years and involved two cycles of full-scale field tests and a complete re-write of the game package (Ellington, Langton and Smythe, 1977). First, a prototype version of the game was produced and field-tested in two local schools during the summer of 1974. These trials showed that the game was basically sound, but revealed a number of minor flaws both in its structure and in the form of the game package. (These flaws were identified by means of a pupil questionnaire, detailed reports submitted by the organizing teachers, and observation of the trials by the authors.) During the following winter, the game was completely re-written and a second, much more extensive set of field-tests was held in the summer of 1975. These showed that the faults had all been eliminated, and that the game was now suitable for use in schools.

Another of the exercises devised by the authors -'Fluoridation?' - was developed in a similar fashion (Percival and Ellington, 1979). This is a role-playing exercise simulating a public meeting called to discuss the question of whether to add fluoride to the public water supply. In this case, the prototype version of the game was not only thoroughly field-tested at both secondary and tertiary level but was also submitted to a number of Regional Dental Officers and Health Authorities for criticism. Feedback received from these sources was of great assistance in producing the final version of the package which has now been incorporated in a number of Health Education courses in the U.K.

Phase 3 Production and Exploitation.

The third phase in the process of developing an educational game or simulation (the production and exploitation of the final package) is one that is generally neglected and often never even reached. Clearly, the external sponsor or publisher assumes a vitally important role at this stage, since, in many cases, it would be extremely difficult or even impossible to make the package generally available without his support.

For example, the final production and promotion of 'The Power Station Game' would not have been possible without the sponsorship of the Institution of Electrical Engineers. Approaches were made to a number of commercial publishers regarding this exercise, but none of these was willing to risk publication - partly because of the unconventional nature of the package and partly because of the uncertainty that it would prove commercially viable.

The IEE, however, were willing to take this risk, since they felt that they would be making a significant contribution to education by making the package generally available. As it turned out, 'The Power Station Game' has proved to be extremely successful, and has led the IEE to publish a number of other games of a similar nature (Ellington, Addinall and Smythe, 1979).

Another game that would certainly not have seen the light of day without an external sponsor is 'North Sea', a family board-game based on the North Sea Oil Industry.
This was developed by two of the authors for Shell Expro. U.K. Ltd., who wished to use it for publicity purposes during the International Offshore Europe Exhibition and Conference held in Aberdeen in 1975 (Ellington and Addinall, 1975). Six thousand sets of the game were produced for Shell by John Waddington Ltd. (at a total cost of over £ 25.000) but the game was never placed on the market outside the Aberdeen area. During the last few months, however, the game has been converted into an educational exercise for use at secondary school level, and is shortly to be published by the IEE. The game is also to be incorporated in the 'Science in Society' course currently being developed by the Association for Science Education in the U.K..

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Calamix.

1. Purpose.

The simulation/game model was designed to introduce and motivate first year chemistry students, actually secondary school pupils with interest in chemistry, for problems arising from the interface between science and society. An important focus of the model would thus have to concern the political processes associated with the setting of industrial, technological and social norms like acceptability of hazardous substances like fosgene, acceptability of risks in general, etc.

The student cognitive level regarding these aspects was considered to be of a very general character. This necessitated, as a second point of departure, the incorporation of all information bearing upon possibly relevant problems in the game.
Third condition to be met in designing would be to keep it manageable, comprehensible and above all enjoyable.
Going from here we (1) chose as a theme for the game an actual neighborhood problem: the proposed extension of an existing chemical plant in our region riddled with

unemployment problems.
This theme and the conditions mentioned largely determined the atoms from which the model was te be built.

2. Elements of the game.

The main ingredients provided by the theme are formed by the interaction between (un)employment questions, environmental problems, and the political process. The interactions are provided by five separately roomed groups of participants, each of whom represents an important social aspect: government assisted by two committees of experts, plant management , trade union, press, and a citizens' action group. (see frontispecies).

In order to model government it was decided to collapse all governmental levels into one, the municipal government, supposing it to be closest to the experience participants might have with any form of government. The governing body consists of a burgomaster and three aldermen. They are assisted by two expert committees, one on unemployment and one on fosgene, which are housed in the same room, thus guaranteeing easy access to the "corridors of power". The burgomaster functions in a central role, because he is the chairperson in each hearing and meeting. (S)he must function as objectively as possible. The three aldermen are assigned each an area of competence: economics; social affairs; environmental and health issues. All are provided with rather general information.

Plant management was requested to make as large a profit as it could.
In order to do so realistically, they were provided with a plant model which allowed them to calculate the influence of all kinds of variables like costs of labor,

pollution control, safety, raw material prices, etc. on the profit margin. Management possessed all relevant technical detail on processes, effects and costs. However, not all of it was easily accessible. An extension plan was the starting point of the simulation/game.

The moment it has become known that the plant CALAMIX has applied for a land claim in the industrial area of the city of Eemsstad, the game starts. The citizen action group tries to become informed about the CALAMIX extension plans. The group counts under its supporters at least one close neighbor to the plant and/or one scientist. They possess all the information relevant to the dangers of the processes and products of the plant. This information, however, is present in widely dispersed form like articles, reports and memos. They were supposed to defeat the extension plans with all methods they themselves consider admissible. In all simulation games played so far they were even told they could hold sit-ins, but this has not happened yet.

The press were supposed to produce a newsletter every two or less hours. The newsletter consists of a single sheet of A4 paper with typewritten items. After photocopying it was distributed to each participant. Editorial policy was free. We usually even provide room for dissenting opinion papers. The press possessed only newspaper cuttings as information.
The trade union consisted of a few employees of the plant and a few union leaders. The group possessed information regarding safety and the unemployment situation in the region, again up-to-date reports, etc.
The trade union's acronym, ABC, stands for workers interest center.

3. Dynamics of the simulation/game.

Here the essence of our approach to simulation/game building lies and is contained in three principles:

3.1 A simulation/game has to contain as few directives as possible to allow the greatest possible expression by the participants.

3.2 A time structure, explicitly introduced or implicit, is the backbone to get things moving.

3.3 there has to be enough structure so things one is interested in stand a fair chance of happening without the participants getting fed up either by being manipulated or bored.

In practice this works out to the following communication structure.
Every group can communicate with every other group mainly in writing.

Oral communications are possible only after written applications have been filled in and accepted. The press, however, can walk in and out everywhere, inhibited in doing so only by the inhabitants of a room not wanting the press present during deliberations or conferences.
The overall time structure provided in the game is given below.

TIME	EVENTS
0	- reading and absorbing the general situation, instruction on communication rules and more specific group instructions.

TIME	EVENTS
30 mins.	- beginning of written communications
60 mins.or earlier	- each group sends a press bulletin to the newspaper(s).
90 mins. or earlier	- the mayor has organized and publicy announced a hearing regarding the extension plans of CALAMIX

AFTER THE HEARING

	- oral communications in the form of conferences become possible
90 mins. or earlier	- the first munical meeting must be held. In this meeting a proposal from the municipality regarding a social statute must be discussed. Further points are procedures to be followed for CALAMIX to get waste and other permits.

AFTER THE MUNICIPAL COUNCIL MEETING

60 mins. or earlier	- a second hearing must be held regarding the permits for the CALAMIX extension plans.

AFTER THE HEARING

60 mins. or earlier	- the municipal council meets again to take the final decisions on CALAMIX plans.

More hearings or council meetings can be organized freely. The above is minimum. Hearings take a maximum of 20 minutes and council meetings a maximum of half an hour.

The municipal council consists of participants delegated from each group. The manner of delegation has been fixed beforehand, supposedly by elections, in such a manner that according to their group preferences the council was balanced regarding the extension issue. Since the simulation/game has been played four times now, and we have had two extensions it can be considered as a correct set-up.

The simulation/game takes a morning and the greater part of the afternoon to play without interruption. Usually lunch is provided during the exercises. The same evening or the next morning there is a debriefing session.

4. Debriefing.

Debriefing centers round four issues. First it is important to make clear to everybody what has happened. We usually provide for this by letting one participant from each group report. In this report the aims of the group and their feeling of success combined with more factual details are delivered. This provides for the second issue of the debriefing centering on the question:
"How well did we do"?
First we discuss that each group should be judged by their own aims and criteria. Next we discuss the suitability of the game model as a whole. This is of course a function of the match between game and players. Therefore one sould ascertain this match by asking on what points participants felt the model was inadequate.

This brings us to the final point to be discussed in the debriefing. Links between science and society, or the environmental issues, unemployment problems, or technological policymaking, in short the ulterior purpose of the exercise.

Notes:

(1). The simulation/game has been developed in cooperation with Dr. P. Vergragt, senior lecturer Science and Society, Chemistry Dept.

5.6 In language teaching.

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Using role plays with adult beginners in foreign language classes.

Learning a foreign language requires a great deal of practice in speaking and communicating. The language teacher's task is to create situations - necessarily artificial - in which the learners can easily use the newly acquired language.
Unfortunately, adult learners are notorious for their reluctance to speak.

In real-life social situations, the adult learner is inhibited by his inability to cope in a foreign language with situations which cause him little trouble in his own language: "When using his mother tongue, the mature adult has learned a complex body of social and linguistic rules which have made him a fully integrated member of a number of interlocking social groups.
He knows how to behave with them, what to do and what to say, when, where, how and to whom. When the same adult becomes a foreign language learner, he suddenly finds himself confronted with arranging situations, which despite all the knowledge and skills he has built up in his previous experience, he is incompetent to handle, whether at a public or a private level". (Trim, 1977)

In classroom situations the inhibitions are less sophisticated but perhaps more pressing. Participants in company language courses, for example, may be shy of speaking in front of superior or inferior members of the firm - either because they are too good, or because they think they are too poor. Many adults carry with them unpleasant memories from their schooldays: the scorn of their peers, the intolerance of schoolteachers with the less able pupils, or the continuing stress they have having to succeed in pending examinations. Further, because the social setting of a language learning situation is new, most learners have inhibitions about speaking in front of their peer learners. At the elementary level of language acquisitions these fears play a greater role than the fact that the learners have inadequate language at their command to express their mature thoughts. Although the inhibitions which occur in complex social situations are very real, the situations in which the adult beginner learning a foreign language finds himself are simple, straightforward situations; and these - because of the lack of language - are easily mastered. The problem confronting the teacher is how to reduce the inhibitions which the adults display. Role play offers one good way of doing this.

Role play, in English language teaching terms, is well defined as a situation in which "(a student) is speaking not as himself/herself, but as a character whose ideas may be ad variance with those of the student". (Wright, 1979)
By including in the definition the word "ideas", however, the author necessarily restricts role play to students who are well beyond the elementary stage: the possibility of expressing ideas is limited for beginners. However, it is possible to set up role playing in the classroom, even with beginners.

The question to be answered is what constitutes a role play, as opposed to the mere repetition of scripted lines.

The following examples of television sequences from the multi-media language course FOLLOW ME (1) show how learners can be introduced to role play at a very early stage.

The following dialogue is hardly a role play in traditional language teaching terms:

Woman: Good evening!
Man: Good evening!

However, this scene as played on television involves two actors, neither of whom needs to practice the language concerned, both of whom, however, are - by profession - playing roles:

Television sequence: A man is waiting for his girlfriend in a bar. She approaches him, unseen, and surprises him, saying: "Good evening". He smiles, and stands up and greets her in turn.

This example shows that "ideas" and "advanced language" are not necessarily ingredients in a role play. However, in practical terms, it would be difficult, and probably unrewarding, to persuade two adults in the bare classroom to try and re-enact this romantic television scene.

Other scenes from television, however, can provide a good model for a role play which uses a limited amount of language in a carefully controlled situation. Consider, for example, a teacher who asks his class to prepare weather forecasts for homework. In a subsequent lesson he may well ask around the class for a few weather forecasts to be read out.

The situation for the learner is that he is being asked to read out a written exercise for the whole class and the teacher to hear. If a television weather-forecaster is taken as a model, however, then selected pupils can be asked to read their weather-forecast from the front of the class as if they were on television.
Suitable measures can be taken in the classroom - maps on an overhead projector, cut-out cardboard box to be used as TV-screen, or whatever. Here the reading of the weather-forecast takes on an entirely different character. The peer learning group pays far greater attention to the role playing student; the student sees far more sense in his reading out his small part. Of course, not every student would be willing to play the part of the weather-forecaster, even if time allowed it. But this is no criticism of the use of different language teaching techniques with different pupils in the class.

The aim of a role play should be to allow the learner to use whatever language he has at his command freely, but correctly, in the appropriate situation. Controlled situations - such as reading the weather-forecast - are necessary at first to build up confidence, and, in the beginning stages with the pupils, to introduce them successfully to the idea of role playing. The following technique of using the videocassetterecorder in class illustrates well how learners can be made fully familiar with the language used in a situation before they themselves are asked to role play the situation. The video sequence, taken from FOLLOW ME, occurs in week 7 of the course - that is, after 20 learning hours for part-time students who attend classes twice a week. The dialogue is situated in a British customs Hall:

Customs official: Good morning, Sir. Are these your suitcases?
Vicar: Yes, they are.
Customs official: And is this your suitcase?
Vicar: Yes, it is.
Customs officer: Would you open this one?
Vicar: Yes.
Customs officer: Excuse me, what's this?
Vicar: It's a bottle. It's a bottle of wine.
Customs officer: And this? What's this?
Vicar: It's a bottle, too. A bottle of perfume.

We will assume that this dialogue has been introduced, new vocabulary and structures practiced, and that the participants are ready to move on to role play. By using the pause button on the video cassette recorder the teacher can elicit from the students suitable responses to the customs official's questions.

Notice that this is not a repetition (the learners speak before the answers are given), but closely controlled reproduction of known speech. The answers from the course participants need not be word for word the same as those which will be spoken on the screen. It is enough that the answers match the situation and express the correct intention. These points are made clear by the following examples:

Teacher starts video machine:
Customs official: Good morning, Sir. Are these your suitcases?
PAUSE BUTTON
Course participant: Yes, they are.
FRAME RELEASE
Vicar: Yes, they are.
Customs official: And is this your suitcase?

PAUSE BUTTON
Course participant: Yes.
FRAME RELEASE
Vicar: Yes, it is.
Customs officer: Would you open this one, please?
Vicar: Yes.
Customs officer: Excuse me, what's this?
PAUSE BUTTON
Course participant: It's a bottle of wine.
FRAME RELEASE
Vicar: It's a bottle. It's a bottle of wine.
Customs officer: And this? What's this?
PAUSE BUTTON
Course participant: A bottle of perfume.
FRAME RELEASE
Vicar: It's a bottle, too. A bottle of perfume.

and so on....

The teacher may of course have written some key words for the answers on the blackboard or overhead projector - or better, still, asked a course participant to do so.

Once the class is familiar with the sort of responses which are required in a situation, the teacher can move on to a freer role play. An adult class is invariably of mixed ability; those who are not yet able to take part in the above role play can nevertheless act out the role of travellers who walk unquestioned through the green channel.

Even at this elementary stage the theatrical aspect of the role play must be emphasized. The learners should be encouraged to respond in any given situation with a range of emotions.

The adult learner, who expects to use his language in any way, must be ready to deal with a variety of situations in which he must use many different language functions: complaining, expressing admiration, being bewildered, asking for information, and the like.

A video cassette recorder, although a very useful tool in language learning, is of course not available to all teachers. Nevertheless, a role play which involves moving away from the original theme of the stimulus material can easily be set up in class. FOLLOW ME includes a sequence where the characters are choosing fancy dress clothes for a party. All the characters express a range of likes and dislikes, depending on which costume is chosen. It is obviously beyond the resources of most teachers to equip their class as a theatrical costumier would.
Here the teacher can call upon the many other resources available to him. In the following example the teacher uses flashcards (and smaller cards for group work) which illustrate drinks:

Teacher shows large flashcards to the class, identifying for them the drinks (or asking for the drinks to be identified). The teacher then asks a student whether or not they like the particular drink. This is now a real situation, in which the course participant gives his own opinion.
The teacher then distributes the small cards to groups of learners. The scene is set: they are a group choosing drinks for a party. The elementary roles assigned to each person are that they must strive to have at the party only drinks which they like; in the role they can like or dislike any of the drinks under consideration.

The course participant can use any strategy he likes to get his way - pleading, ignoring other peoples' suggestions, shouting - but nevertheless remains within the language area appropriate to the situation. If we are to regard language teaching to adults as something more than merely giving them an equivalent in a foreign tongue then we can see that for many course participants (who are rarely in learning situations) that much can be learned for their own personal development from the situations created by role play.

A true role play goes beyond mere language practice in a situation. The learners must be required to move outside themselves, and not merely repeat lines written for a given situation. We have mentioned above the use of emotions or strategies in argument. Other determining factors in a role play could include speaking in an unusual register; adopting different sociological roles; speaking from a view point of another generation; or playing the part of the opposite sex. Obviously such a list of factors can be endless.

However, it is worth noting that the more complex the determining factors become, the more the role play moves away from mere language repetition and practice.
It takes the course participants - including the teacher - into areas of adult life where everybody's education is continuing, even outside the language classroom.

Footnotes.

(1) Follow me.

Follow me is an international project which has produced a multi-media English language course for adults. The learning aims are those of the Council of Europe Threshold Level and the West German Association of Adult Education Institute's Grundbaustein zum VHS-Zertifikat. Apart from these two institutions the cooperating bodies include: Bayerischer Rundfunk (BR), British Broadcasting Corporation (BBC), Hessischer Rundfunk (HR), Norddeutscher Rundfunk (NDR), Westdeutscher Rundfunk (WDR), Österreichischer Rundfunk (ORF), Schweizer Fernsehen (SRG), TELEAC (Niederlande).

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5.7 In art education.

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Art arena games: education through art.

1.0 Introduction to and origins of the Art Arena games model

ART ARENA is the name of a game-model in which a group of two or more players collaborate to produce a large artwork, usually a large painted mural. In this introductory paper I shall refer mainly to these paintingbased games although some mention will be made later on of alternative dramatic and three-dimensional media which have been used.

The basic game structure involves two or more teams using a set of 'strategies' to make a painting based on a particular theme or 'scenario'. The designs arising from the different strategies are then mapped into the mural surface so that they overlap, and are painted according to a set of 'tactics', the aim or 'target' of the game being to create an appropriate balance of the different teams' interests. In perhaps the simplest game, 'Squircles', the two teams have to enlarge and fuse their original separate plans, the one based on strategy rules for drawing circles and the other on squares. Every game has this basic four-part structure, including:

Scenario - the theme, subject or story-line

Strategy - the guidelines to the different teams as to how to express their particular part of the scenario, i.e. their design opportunities in colour, line shape and effect

Tactics - the rules decided upon by the teams as to how they are to paint, and what to do where shapes overlap, etc.

Target - the superordinate aim of the game, which is always to achieve an appropriate balance of all teams' interests, expressed in terms of the particular scenario.

The details of how the games are played and the roles of the teams'rules will be made clear when I go through the game step by step. Before this, however, I shall say a little about the origins of the games.

1.1 The game format developed out of a recreational project started by Don Pavey of Kingston Polytechnic for local children. On the basis of their activities in this workshop he identified what seemed to be four important aspects of their learning which might be further explored in the gaming medium:

1 Scenario scan : the process of exploring and assimilating data about a particular theme or imaginative project.
2 Strategy: the logical thinking-through of how to implement a design or project, such as devising guidelines for the use of particular colours and materials.
3 Tactics : the physical skills and sensibility in handling materials in the field of play.
4 Teamwork: the ability to plan and work as a team, including team evaluation and criticism of the final product of a project.

When the game workshop was eventually established at Kingston Polytechnic the Art Arena game-format was devised to incorporate and to monitor these four components separately.

This became the basis of the units research into 'Education through Art-based games'. Since then games have been played there regularly by both school children and students of different disciplines within the polytechnic, and other visiting students, studentteachers and tutors, including groups from abroad.

The games were first played outside Kingston in 1975 at the World Congress of the International Society for Education through Art, and soon after at the World Conference of the National Association for Gifted Children. The games have more recently been used in a number of schools and colleges, and their role and value in this context will be discussed further in the third section of this paper.

2.0 The structure of an Art Arena game

2.1 Scenario

The game begins with the reading out of the scenario by one player. Game themes may be virtually anything from the binary system to art history. Over a hundred existing game scenarios are drawn from domains covered by ordinary school subjects, but other games have been devised based on purely imaginative, often science fiction story lines. A number of props such as pictures and models may be used to help set the scene. The game most used in the recent research project is called 'psychon' and its scenario begins:

"You are an island in a cosmic mind"

Each scenario is such that it has conflicting or contrasting aspects which have to be combined or reconciled. Each of these become the concern of one team. The four teams in the 'psychon' game are the four different island of the Cosmic Mind:

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Logica - logical patterning, interlocking elements
Dyno - Powerful, large scale, forceful elements
Splat - spontaneity and radiation, and
Esoterica- the visionary and occult.

2.2 Choosing teams

The next step is to choose teams, either informally or as part of the game by choosing colours previously allocated to the different teams as appropriate. The teams sit together and are told to read out their particular strategies, their role in the game and how they are to plan their design. Each player, using a scaled down version of the mural-grid plans a complete design. Examples of plans using the teams trategy rules may be included in the instructions. The degree to which individual players show originality in departing from 'such' examples has been looked at in the research project.

2.3 Team conferences

When each player has more or less completed a plan (usually after about ten minutes) the team gets together for its first conference. The purpose of this is to assemble the most liked or most appropriate parts of members' plans to form a new Masterplan. Teams may be more or less sensitive to the feelings and desires of individual members as to which plans and parts of plans are included. The masterplan may be a redrawing of the elements of the individual plans or these may be cut out and stuck into another planblank.

2.4 All team conference (before drawing on the mural surface)

At this stage the teams may get together to compare their different masterplans, possibly using an illuminated slideviewing table to superimpose them and identify areas of overlap. Alternatively, the teams may begin straightway to draw their designs up on the mural area using a different coloured chalk for each team. In this case, one member of each team may be elected to act as a "Stabilizer' - whose role it is to negociate with other teams' stabilizers as to

i) those areas they do not mind sacrificing to the other team
ii) areas where a compromise such as colour-mixing, over-painting or interweaving designs is possible
iii) those areas which are crucial to the team's design and may not be given up or over-compromised.

The stabilizers then inform their teams as to the outcome of their negociations.

2.5 Allocation of roles

At this stage another option may be introduced. In a game involving large teams further roles may be introduced so that not all the team members are involved in actually chalking up on the wall. The process of transmitting information from a masterplan to the mural is broken up into a chain of transmission, bringing the added dimension of a communication relay to the game. The roles in this process include:

Callers who transmit drawing instructions to their teams' Designers (drawing at the mural face) by calling out the coordinates
identifying squares on the mural, square by square, e.g. "A9, B2 - red (or whatever else should go in them)" or "A5 - 10 - a green stripe". In this way the design is enlarged and transfered to the mural, square by square.

Other team members may help as Designers or may select and mix paints, cut out materials, etc.

2.6 All team conference (after drawing on the mural)

When all the teams have drawn their masterplans in chalk on the mural surface a team conference is usually called. All the players stand back from the mural and discuss how to combine overlapping motifs, with a reminder that the object of the game is to represent teams' interests in a balance and unity appropriate to the scenario. Teams state their intentions about effects and imagery they wish to use and 'overlap' contracts are negotiated. When decisions concerning the major areas of the mural have been made, painting can begin. Other areas of overlap and conflict may be negociated by individual players at painting projects, and may lead to further team conferences being called.

2.7 Painting begins

This is the Tactics stage of the Game during which players' individual skills and teamwork combine to realise the teams' strategies. As painting proceeds additional ideas and images are added and players increasingly think in terms of the whole mural rather than its parts. This stage of the game usually lasts about 2 hours but this will vary with the age and spontaneity of the players, the complexity of the strategies and the media used. There is rarely any problem deciding when the painting is finished, time and space have usually run out and at this stage a consensus of opinion tends to arise naturally.

2.8 Evaluation, the voting system

The final stage of the game is the evaluation. The game is assessed both as a group achievement, and as a successful event. In recent months an additional self-assessment has been included and moderation of this by the group.

Each player gives scores out of ten on the following criteria, which are read out by an Announcer from the group:

1 Scenario : How well have the needs of the scenario been fulfilled?

This is really an assessment of the imaginativeness with which the information in the scenario has been interpreted and realised.

2 Strategy : How effective were the Masterplans in producing the result?

This vote relates to the skill and imaginativeness with which the teams were able to decipher and organise their visual data in a useful masterplan, and how they coped with solving the logical puzzles and complex concepts contained within the scenario.

3 Tactics : How much skill, artistry and ingenuity was shown by the group as a whole in handling the materials.

4 Teamwork : How well did all the players work within and between the teams?

These first 4 votes are an index of the group achievement while the next 2 votes determine the overall success or failure of the game both as a finished painting and as a cultural event;

1 Target : How well were the interests of all the teams, according to their own strategies and aims, realised and appropriately balanced in the final product? This vote is in a sense a test of how far the superordinate goal of the game has been achieved and often reflects both the individual and group sense of achievement.

2 Enjoyment : How much fun was the whole game?

> Feelings expressed in relation to this vote reflect both the appropriateness, interest and potential of the scenario material and the group experience of the particular players, i.e. the motivation of the players and the acceptability of the project.

The game is judged successful if the scores on these two votes show an average of more than 40%. The game has been won and no one has lost. A result of over 70% is an occasion for cheering and clapping. A game is lost, and decried a cultural and academic failure when the mean for votes over all the categories is less than 40%. The selfassessment and moderation votes may have particular significance when games are used in educational and therapeutic settings. They afford the players an opportunity to learn how their participation in and contribution to the game was experienced by other players. Reserved, timid players may find themselves being coaxed to be more assertive next time and the child who painted one tiny area very painstakingly and who may feel on looking at the whole that they only did a tiny bit may learn how others see and may be value such a contribution. The honesty and lack of malice with which fairly young players can use this vote can be startling.

A game's duration varies with the age and skill of the players, the nature of the target and the context in which it is played. Adults may paint more cautiously and take longer, and games may be designed to proceed slowly. On the other hand eliminating certain parts of the game, such as calling the coordinates out to other 'designer' team members may simplify and speed up the game.

The size of the groups playing games has varied similarly. A dramatic performance-game out of doors can include large teams and recently a group of thirty school children successfully completed a paintingbased game.[3] However a more usual and easily coordinated number of players is between eight and twelve.

3.0 Target groups and areas of application

The areas in which Art Arena games are in use are continually broadening. The original target groups in clubs, schools and colleges are now being joined by other specialist groups for whose interests, abilities and problems the games may be adapted. In this brief survey three main areas of application will be mentioned, the recreational, educational and therapeutic. Clearly a number of the contexts in which the games are used span two or all three categories.

3.1 Recreational Applications

Group-based creative activities such as mural painting have been popular in play schemes and youth clubs for some years but the Art Arena game format introduces and focuses on several important aspects of such activities. The most important of these in my view are those which may be seen to relate to the non-competitiveness of the games. Not only are the games non-competitive in that no single individual or team can win or lose, (this is rather the responsibility of the group). The very structure of the game, while allowing every player to contribute to the whole, actually ensures that individual designs are assimilated, and become the property of more than one person in the game, firstly as they are combined in the team masterplans, and then as these are chalked up on the mural, and finally as changes and embellishments are made in the painting stage. The apparently formal structure of the game in fact ensures a flexibility of roles and activities so that you may end up painting-in something that other people have designed. This prevents the usual competitive organisation emerging, each person designing, drawing and painting their own particular area of the mural. This has important implications when games are used in fairly sensitive group settings - each child can contribute but none can win outright. Although individual children's personalities may dominate the event only very rarely do they dominate the actual mural painting. Once when this did occur was when the group as a whole was being less self determining and honest - when outsiders came in to film a game in progress. Negotiating was more inhibited than usual.

3.2 Educational Applications

The educational applications of Art Arena Games are perhaps the most obvious and direct. Even when played for primarily recreational purposes players' own knowledge and interests become incorporated into the games they invent and are thereby shared with other players. The range of subjects already used in scenarios has already been mentioned and as Pavey (1979) has suggested in a formal educational setting these scenarios may be varied to carry as little or as much data as the teacher thinks appropriate[1]. For very young or E.S.N. players the games can be extremely simple, using only two teams whose tactics are described in terms of basic shapes and colours.

Perhaps the single most important feature of the games and that on which their potential implications for and contribution to education rest, is their non-competitive or perhaps more accurately their supra-competitive basis. The target defines a goal to be achieved for the games to be a success, which overrides competition between individuals or teams. This is not to deny that individuals can take a pride in contributing their best to the game. Whatever each player introduces into the game through their design in response to the scenario is a valid, positive contribution but one which is subject to some extent to moderation by the group. Educationally, rigid subject boundaries are eroded both by the use of painting or drama as the medium for learning about matters traditionally assigned to very different school subject categories and by the opportunity the game structure provides for children to use whatever pre-existing or developing imagery in their painting which helps them personally understand the new information in the scenario. The notion of what data is relevant and what is irrelevant to the subject matter (the scenario) becomes far more open, flexible and dependent upon the knowledge and imagination of the particular group of players. The value and importance of using a child's existing visual imagery as a vehicle for learning new concepts has been increasingly recognised in recent years (q.v. Donaldson, M. (1978) Children's Minds, London: Fontana).

The lack of any complex strategic rules ensuring that one player's positive contribution is another's loss, and the need to "win by sharing" has a further important implication for the invention of games. It makes them much easier to invent than traditional-type games, and well within the capability of even the youngest (6 - 8 years old) players. (e.g. Sportsday game, invented by an 8 year old).

Overall the games require the active, inventive and imaginative participation of the child in the learning process, which becomes a complete cultural-educational event. The social situation itself, particularly if a child's own game is being played, blurs the teacher-learner distinction, and the teacher may take on a primarily organisational role of orchestrating the event. In a loosely educational youth-work context it is important to overcome the provider/provided for roles, and these games enable the group to take an active part in planning and giving something of themselves and their own interests and hobbies etc. For example, in my work with a group of adolescent girls they immediately had the idea of using their favourite pop music and film themes as the scenario. The games' orginator sees them as a new kind of educational project system which educates in and through art (Pavey 1979). The game invented and played so far demonstrate the sheer range of subject matter from the mathematical and scientific to the historical and mythological which can be approached and genuinely communicated through art. Slides of the murals from some of these games will be shown at the end of this paper.

Art products resulting from the games have included a 3-dimensional spring festival dragon, ceramic murals, tapestry designs and a playground movement and drama game in addition to painting games.

3.3 Therapeutic Applications

The non-competitive nature of the games is proving valuable in rather different less formally educational settings. Their open-endedness and single cardinal principle that the "rules" belong to the players and may be modified at any stage by consensus fits them for use in situations where the keynote is education through rather than by or in art. For example, the games may be used to provide a medium or vehicle for particular types of social group-experience.

The often unfamiliar cooperative format highlights interaction between players and recognises the potential role of individual differences and conflicts they may lead to by building them in as an integral part of the game. In all cases, but especially in this type of group situation the game itself as a social and cultural event is as important, and may be more important than the finished art object. In my own work with adolescents the focus on interpersonal communication seems to have made art itself more interesting to them while at the same time the collaborative basis takes some of the focus off individual performance,about which they are often extremely insecure.

Group mural painting has been used for some time in more explicitly therapeutic contexts, in group psychotherapy and growth groups for both clients and trainees. In such cases the painting process is allowed to proceed fairly freely and at the end the whole event is reviewed and may be used as the starting point for exploration. The therapist or group leader usually observes how players are relating to one another and how the art work is developing. Alternatively, a mural is often used just as a statement at a particular, possibly significant point in time, of the state of the group. What the Art Arena structure offers such situations is a means by which greater explicitness can be brought into the event as it happens. All the players are in a sense participants and observers in that at points throughout the game they are required to become aware of their own position, role or contribution in relation to the whole group and the whole painting. The team and group conferences allow dissatisfactions or problems of power and dominance and over-reticence to be dealt with immediately rather than after the event. Although the game format has had very little testing out in such an overtly therapeutic context, it would seem from my experience to offer a means of concretising events, within the context of the game and the team's aims etc. Games have, however, been played in one Occupational Therapy department of a

College of Education (Ripon and York St. John) and the therapist, Eileen Rennison, has found them interesting and successful [2].

Figure 1

The scenario Players familiarize themselves with the topic of the game by looking at and handling all the things which have been collected together to set the Scenario. (The game being played is a Sci.Fi.game called Psychon)

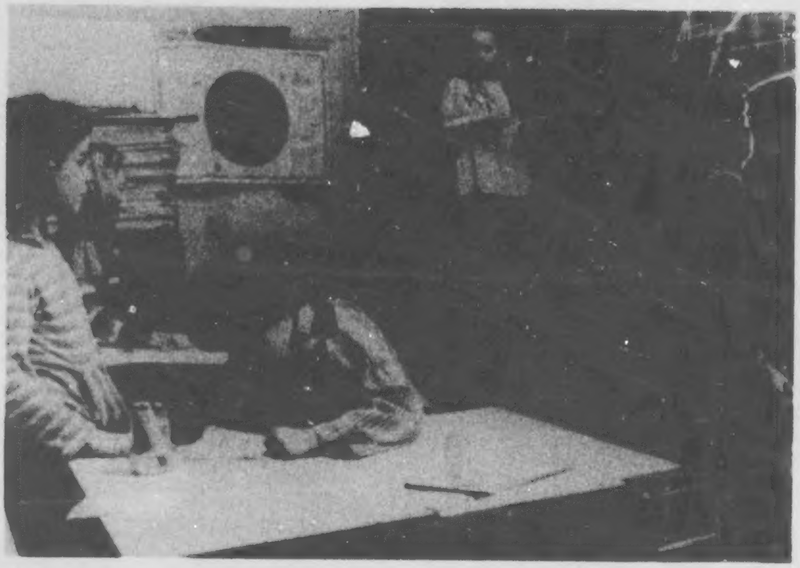

Figure 2

Strategy A Planner at his Headquarters (the table) is selecting co-ordinates and colours to give to the Caller (left) who will call this data to a Designer (centre waiting at the wall). (The game being played is called Planet of the Apes)

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Figure 3

Teamwork Representatives of the teams, one after another, explain which territories they need to have or share in order to preserve their identities. Players balance their teams's interests against those of the groups as a whole. The ga

(The game being played here is Treasure Trail)

Figure 4

Tactics Players manoeuvre and interweave on the field of the play, using hands, instruments and media.
All moves are simultaneous and never alternate.
(The game played here is Treasure Trail;Geography and English)

Figure 5

Evaluation Players conduct the voting and evaluate the successes and failures of the game. An Announcer (holding the microphone) introduces the assessment and calls the names of the voters, who explain why they have voted high or low. A Commentator reviews the game and explains the voting categories, and a Recorder (right) enters votes onto the Score Chart. (The game here is Treasure Trail)

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Chapter 6:

Simulation/Gaming and policy-making

6.1 Dr. W. Thomas Nichols, International Studies Institute, Department of Political Science, Westminster College, New Wilmington, Pa., USA.

How to simulate a political process, national or international. A contrast between making your own simulation and using a published one.

Simulating a political event or process is an instructional tool which can be used effectively in the classroom, or a tool which can be ineffectively applied and a waste of time for both teacher and students.

Political simulations and games, also called political gaming (Rosenau, 1961), can have a variety of objectives. One goal is to sensitize the participant to what it feels like to be a member of a minority or oppressed group. *Sunshine* and *Ghetto* are two games designed to create such empathy. However, Samuel Livingston in 1971 studied a group of students four months after they had played *Ghetto*, and found no lasting change in attitudes revealed by a survey before that game was played.

The game *Ba Fa, Ba Fa* was designed for the U.S. Navy and has had wide application in American classrooms. It has been used in the author's classes to create understanding of cultural differences as students simulated a money-driven society and a quiet easy-going one. Without exception, the students involved revealed in extensive debriefing sessions that they realized in greater detail the impact that cultural differences play in international relations.

Games and simulations can be used to develop greater cognitive knowledge. In 1966 Sarane Boocock and James S. Coleman studied several games and hundreds of students and found that the students did develop a good group of concepts and facts by playing simulation games. However, an even more massive study involving 4,539 students in 47 games led by 87 teachers found regular teaching methods and simulations produced no appreciable differences in knowledge gained between traditional classes used as a control and classes undertaking simulations, (Fennessey, et. al.,1972). Therefore perhaps it is in error to claim that simulations are a better tool than other means of traditional instruction, but they can be equally effective (or equally ineffective), depending on the teacher.

Historical simulations are often made of an important event in a nation's history, such as the American Civil War, or a major international conflict. For example the Korean War provides the background for Dangerous Parallel. The countries are disguised, but students are quick to identify all the major powers involved.

The British entry into World War Two, or the Norwegian decision not to join the European Economic Community are examples of situations easily simulated in the classroom if students have access to historical documents such as Hansard for the British Parliamentary debates.

The major advantage in using a published simulation or political game is that the package is usually self contained and seldom requires the teacher to look for the necessary materials or to explore the subject thoroughly enough to create rules and the scenario to be followed. Sometimes there are reviews which evaluate the simulation/game.

A case in point is Inter Nation Simulation. This exercise was created in the late 1950's (Guetzkow, 1959). It has been revised and a computer program has been devised by Bahram Farzanegan and Ron Parker. The new version uses BASIC computer language and simplifies the bookkeeping of the earlier model very much. (Farzanegan and Parker, 1978).

Yet criticisms have continued. David Schwartz pointed to personality factors in the real world which are not capable of being easily simulated. Amin, Hitler, Napoleon, Churchill. Who knows when such a charasmatic leader will evolve? (Schwartz, 1965) Bernard Cohen warned of the tendency, especially of undergraduates, to make a simulation/game more of a sport, a game to be won, rather than an exercise in decision making from which serious lessons could be learned. (Cohen, 1962).

Be that as it may, simulations are still very useful, especially if handmade by the instructor with a specific educational objective in mind for a special group of students. Law schools all over the world use moot court simulated trials to teach courtroom processes to would-be lawyers.

Mock United Nations General Assembly and Security Council sessions are common in many schools. Prior to World War II the League of Nations was often simulated. (Cohen, 1961). Most of these simulations were designed to instruct students in the processes by which decisions are made in the institutional setting being simulated. However, some of these simulations, especially run by the Rand Corporation and M.I.T. in the late 1950's were designed to see if knowledgeable adults could role play through a crisis to see if predictive indications could be discovered for future real-life similar crises. The results of these predictive uses of simulations were inconclusive. (Bloomfield and Padelford, 1959).

From time to time governments have used simulations to consider the possible outcomes of optional strategies, as when the Japanese Total War Research Institute played games in 1940 involving possible agressive moves. As revealed by evidence introduced in the Tokyo War Crimes Trials, one of these games anticipated the Japanese moves in the immediate post Pearl Harbor period when the initial stages of the war were going well for them. (Goldhamer and Speier, 1959).

However, the main purpose of this paper is to explore political simulations for classroom use. Let us turn to one specific topic and examine a publisher's game and a proposed teacher-created simulation. If, for example, a teacher in a non-American classroom wished to simulate one segment of the American presidential political process, that teacher could select the nominating convention as a unit to be studied.

The game Convention was copywrighted in 1960 by Homer Babbidge. (Horn, 1977). It was available from Games Research Incorporated. It is a board game for three to seven players and can be played in two to four hours. The players roll dice to advance around the 14 squares on the board trying to win enough delegates to win nomination at the convention. However, the design of this game is really flawed. The dominant place of chance (by the roll of the dice) removes the key ingredients from the simulation; the choice between candidates based upon differences in their proposed policies, and the political bargaining which symbolizes all American presidential nominating conventions. This simulation teaches certain political terms associated with American political conventions, but as a device to increase understanding of the process, this game is a flat failure.

So how about constructing your own simulation? First the simulator would do well to refer to the bibliography for suggestions as to readings, so that the simulator would be better informed as to the process.
Non fiction (White 1960-1976, and Mailer 1968) and fiction (Drury 1966, Knebel 1965, and Wicker 1973) will be especially helpful.
The simulator can then turn to the instructions, rules, sample speeches, and tally sheets which immediately follow and adapt the Westminster College simulation to meet the requirements of the specific educational needs.

We adapted these rules for our workshop in Caracas, Venezuela in 1976. About 25 Latin American teachers assumed roles as managers and state chairmen, and nominated Senator Birch Bayh on their third roll call of the states.

It can be done using the materials presented here, and some imagination. We believe that educational objectives can be met with this simulation, provided it is conducted effectively. Here are the rules:

Mock Presidential Nominating Convention Instructions (Small version).

Purpose: The U.S. political pattern can be understood better by students who participate in a simulation of the convention by which each major political party selects its candidate for the Presidency.

Setting: This simulation can be run in one classroom with 25 or 30 participants; a larger room is needed for 50 to 55 delegates. A gym or large auditorium is required for a full convention of 1000 delegates, but this is not described here.

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Time required: The number who participate in this simulation, the facility available, and the schedule in which the simulation must fit--all determine the time which is consumed. In general, the convention can be run in under five hours.

Decoration: The room can be dressed up with red, white, and blue bunting. Pictures of the candidates to be considered can be cut from American news magazines. The better the decoration, the more effective the simulation. A platform with podium and microphone, and several floor microphones are required if a large room is involved. Adding machines to tally the votes are also required. If student-run radio, press, and television facilities are to cover the simulation, facilities for the media help make the overall setting more authentic.

Key posts: 1) Facilitator. This responsible person gives overall supervision to the simulation, selects the executive committee, and leads the debriefing discussion after the event is over. It is very important that after the committee selection the facilitator does no work at all until the debriefing, since doing is learning and should rest entirely upon the participants. 2) Executive Committee. A small simulation can be held with a three-person executive committee: chairperson who presides; secretary who records votes; physical arrangements chairperson who arranges the room. 3) Campaign Managers (5). The Executive Committe selects five of the leading American candidates from among the real politicians who are seeking the nomination from the out-of-power party. Campaign managers write the nominating speeches for their candidates or use one of the speeches suggested for 1980 and usually deliver these speeches to the convention. They plan for the demonstrations. Finally, they manage the floor negotiations by which they hope to win the nomination for their particular candidates. 4) State Chairpersons (25 to 55). These persons are selected by the Executive Committee for the larger simulation. For the smaller one, they are the only participants. The function of the state chairperson is to announce the votes for that state on the Roll Call of the States. 5) Keynote Speaker. Not absolutely necessary, but a very fine addition to the simulation. Any politician will do, from town mayor to a national figure. The keynote speaker opens the simulation and gives it a touch of reality, for the person is a real politician and uses the current political rhetoric.

Running the simulation: Assign individuals to the posts above. See that research is done for biographical information to be found in Time, Newsweek, the New York Times, the Washington Post, etc. Have the executive committee draft a set of rules to follow. This must be adopted and followed. Assemble delegates seated by states in the prepared place. After the Call to Order, adopt rules, listen to keynote speaker, then move into the main event. First the states are called for nominations, alphabetically. Alabama may place a candidate in the nomination, or yield to a state which will do so. After each nominating speech, allow time for a short demonstration by the supporters of that candidate. As a rule no more than five minutes should be allowed for demonstrations, and the aisles must be cleared so that the Roll Call of States can continue. States with no name to nominate simply announce "Pass". After all states have been called for nominations, move on to the Roll Call of the States for voting. Arrange the votes on cards and give to chairpersons. If necessary, one person may be given two or more states. Divide the votes up beforehand so that no one candidate is elected on the first ballot. This is done to stretch out the voting to permit floor negotiations to develop spontaneously. It is best to simulate the out-of-the-White-House-party Convention, since a sitting President usually wins renomination easily without serious opposition. As the name of the state is called, the state chairperson goes to the microphone and announces the votes of his or her state as directed on their cards first, then they are free to choose the candidate of their own choice. After the first Roll Call of States is completed, the secretary announces the totals for each candidate. Although 50% plus one wins the real nomination, you might use a rule of 2/3rds plus one--to prolong the roll calls. After four or five votes under the 2/3rds rule, you might switch to 50% plus one--to bring the convention to a conclusion. Campaign managers of the least popular candidates may withdraw and throw support to a more popular person. Roll Calls continue until one candidate reaches the number of votes required by the rules to win. His manager gives an acceptance speech, and announces cabinet appointmens (prizes which encourage the larger states to support one candidate over the others). At the conclusion, the Facilitator may announce awards for best nominating speech. Afterward, a debriefing is held in which participants describe what they have learned about the U.S. political process by simulating this convention.

Nominating speeches

Phil Crane: America needs a new conservative President... the Republican Party needs fresh leadership...and if there is one thing the Republican Party and this great land does not need, it is the same old faces shouting the same old slogans.

The man whose name I will place into nomination is a fresh new face with fresh new ideas. He is the kind of man the Republic Party has been waiting for to lead it to a smashing victory. This man was the first to announce his candidacy over one year ago. He has trudged through the snows of New Hampshire and walked along the beaches of Florida to spread his message and see its acceptance. His message is a powerful one not based on the conservative rhetoric of old. Rather, it is based upon the common feelings of an America that is largely conservative. For the last four years, a Democrat President and a Democrat Congress have ignored the popular sentiment of the people. When an overburdened American taxpayer cries out for a tax break, they ignore it. When a desperate American taxpayer demands a balanced budget, they do not hear it. When an American citizen wants a defense that is second to none in the world, they are not concerned. Our present administration has failed to heed the call of the voters. But...the nominee who has listened to the citizens revolt will be elected President. Let there be no doubt about that. We have such a listener in the Republican Party. This man proposes that by 1981 he would present a balanced budget to Congress and veto any deficits.

This man proposes the enactment of the Kemp-Roth tax cut which would slash one third off the income tax which individual taxpayers are forced to pay.

This man proposes that our military be second to none which would act to deter the agressive expansion of other foreign powers.

This man proposes the elimination of vast segments of the federal bureaucracy through the enactment of the negative income tax which would replace all of the giveaway welfare programs with one program which would effectively serve the needs of the poor.

The former college professor who proposes this as part of his basic platform has served with distinction as a member of the House of Representatives. He has been the national president of the American Union. This individual is a new face with new ideas and new programs. The American public has heard the tired rhetoric of the old voices of the right. They have not been accepted.

The American voter is looking for new leaders with programs in step with the majority of the nation's voters. We have that new voice today. It is with great pleasure that I place into nomination the name of the Honorable Member of Congress from the heartland of the Republican Party and the home of Abraham Lincoln... Phil Crane.

George Bush: The major purpose of this Republican Convention is to make a decision. Our decision will be the choosing of the Presidential candidate to run under the banner of the Republican Party. But our decision will go much farther than that. For the individual whom we choose will be in the position to affect the lives of our future generations of Americans. As a result, we are faced with a most important decision.

Let us decide to nominate a man with solid, capable experience in both domestic and foreign affairs.

Let us decide to nominate a man who can bridge the ideological gap within our Party.

Let us decide to nominate a man who will face our National problems head-on.

Let us decide to nominate a man who will listen to a group of American people who have been neglected for too long--the taxpayers.

Let us decide to nominate a man who will instill progress with order.

Let us decide to nominate a man who can win in November.

Let us decide to nominate a man who will lead us through the 1980's.

Fellow Republicans, and fellow Americans, let us decide to nominate and support the next President of the United States: George Bush.

John Connally: Fellow Republicans and fellow Americans, the man I am going to nominate tonight is the man who will get this country back on its feet again. The man is John Connally. Never before has one man been better prepared for the Presidency. At a time when our elected officials in Washington are weak and indecisive, particularly the man currently in the oval office, it is good to know that our Party can nominate a tough, firm leader to hold the highest office in our land. John Connally will confront our National problems face-to-face. He will restore global confidence in and respect for our Nation among our friends throughout the world.
As President, John Connally will stand up for Republican principles and work hard to strengthen our party at all levels.
A Connally Presidency will bring back respect for America by Americans. He will put a firm and final halt to an overbearing runaway government. John Connally will have the courage to say "No" at a time when Americans want a leader who will say "No" to runaway government spending.
Fellow Republicans, let us unite and nominate the one man who can really make a difference in Washington.
John Connally is that one man.

Howard Baker: America needs strong leadership, and the Republican Party has the individual who can provide that leadership to restore the Nation's greatness.
For the past four years, our country has labored without a leader...without a strong spokesman who can unite our Nation.
Instead we have seen inflation roar to double-digit levels while business and labor are confused and befuddled by a President who acts without wisdom.
For the past four years, our foreign policy has been on a roller-coaster. Every time there seems to be an up, we find ourselves down deeper than ever before. Our foreign policy has made our allies confused and our enemies happy.

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Our economic system has been in a crisis for the past four years. Inflation has hurt and adversely affected all Americans. This is because our current President has been an ineffective leader.

The Republican Party is indeed fortunate to have within its ranks a leader who can guide this country from the depths of despair to new heights of freedom.

This man currently serves as the highest elected office holder of the Republican Party. From that position, he has been a strong spokesman for our Party and the Nation. He has forthrightly and effectively addressed the issues that confront the Nation. He has represented our party in opposition to the Democrat Party. In every speech, in every debate, in every argument, he has won converts to the Party and away from the Democrats with his persuasive power.

America is in dire need of an articulate spokesman, and there is such a man in the Republican Party.

This man I will nominate has deep ties to our great Party. I do not need to remind any loyal Republican that the man I speak of is the son-in-law of the legendary Senator from Illinois, the late Everett McKinley Dirkson...like Senator Dirkson, this man speaks with dignity and compassion for all Americans.

And like Senator Dirkson, this individual knows that in the conduct of our foreign policy, partisanship has no place. Over the past four years, he has served to unite a foreign policy for the best interest of the Nation.

But on the domestic front, this individual stands four square behind the free enterprise system. He believes it is about time to end the regulations imposed on business by the faceless Federal Bureaucracy. Most importantly, he wants to put an end to the pattern of deficit spending and return a balanced budget to the American taxpayer.

All of you know that our goal is to elect a Republican President. We must have the right man to head our ticket and also lead our Party to victory in important state and local elections. During the time the individual I will nominate has been the Republican leader of the Senate, our party has made increases in the number of Senators because of his leadership.

The Republican Party has had this man as a leader, and it is time for him to become the leader and spokesman for the entire Nation. Fellow delegates, with great pleasure, I rise to place into nomination the name of the Republican leader of the United States Senate...
The Honorable Howard Baker of Tennessee.

Ronald Reagan: In these troubled times, there is good news--
Good news for America
Good news for Conservatives, and
Good news for the Republican Party.
That good news is that there is a candidate for the high office of the Presidency who can restore greatness to our Nation.
A man who has great integrity and possesses the necessary ideology and conservative perspective that has been sorely and desperately needed for that individual who is to occupy the White House.
For the past four years, an imposter has been occupying the White House, and we're going to send him an eviction notice this very day. For the past four years, the man who told us he'd never lie has been lying...through his teeth. He gave away the Panama Canal... He gave away Iran... He gave away more welfare payments.
But the current occupant of the White House did give us a few things...like runaway inflation and Bert Lance.
However, there is one individual who can defeat this peanut farmer. This individual has been a strong spokesman for all conservatives. Unlike the peanut farmer, this individual will not change his philosophy once he gets into the

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White House.

For the last 15 years, this one man, more than anyone else, has spoken openly and forthrightly for America.

This one man was in the "front lines" in the fight against the Panama Canal Treaties from the beginning.

This one man was the first to propose laws limiting the amount Government can take from us in taxes.

This one man has stood by our allies like Taiwan and Israel and stood up to those who would abandon them or betray them.

He has fought inflation and deficit spending and he has campaigned for a National Defense second to none.

He has opposed big government and big bureaucracy. Yet there are those who would seek to prevent this man from being President. Those radicals and left-wing liberals are afraid because he would restore greatness to our Country. We must see to it that the man with the best chance of defeating any candidate that the Democrat Party nominates gets the nomination of our great Party.

That man who can defeat any Democrat candidate is the man I am pleased to nominate today.

He is the man who will get Government off our backs and out of our wallets. Fellow delegates, here is the good news...the former Governor of the State of California...and our next President... Ronald Reagan.

Speeches could also be written for any other American candidate your students like.

VOTING RECORD

votes						
12	ALABAMA					
2	ALASKA					
7	ARIZONA					
8	ARKANSAS					
102	CALIFORNIA					
11	COLORADO					
17	CONNECTICUT					
3	DELAWARE					
4	DISTRICT OF COLUMBIA					
28	FLORIDA					
17	GEORGIA					
2	GUAM					
4	HAWAII					
8	IDAHO					
60	ILLINOIS					
26	INDIANA					
15	IOWA					
11	KANSAS					
15	KENTUCKY					
14	LOUISIANA					
5	MAINE					
18	MARYLAND					
36	MASSACHUSETTS					
47	MICHIGAN					
12	MINNESOTA					
7	MISSISSIPPI					
25	MISSOURI					
4	MONTANA					
7	NEBRASKA					
2	NEVADA					
4	NEW HAMPSHIRE					
38	NEW JERSEY					
3	NEW MEXICO					
96	NEW YORK					
22	NORTH CAROLINA					
3	NORTH DAKOTA					
54	OHIO					
12	OKLAHOMA					
11	OREGON					
2	OVERSEAS AMERICANS					
65	PENNSYLVANIA					
2	PUERTO RICO					
6	RHODE ISLAND					
9	SOUTH CAROLINA					
4	SOUTH DAKOTA					
16	TENNESSEE					
46	TEXAS					
5	UTAH					
2	VERMONT					
18	VIRGINIA					
2	VIRGIN ISLANDS					
18	WASHINGTON					
11	WEST VIRGINIA					
23	WISCONSIN					
2	WYOMING					

Note

If you have over 15 hours' playing time available, and either 500 or 1,000 students, you could simulate the larger convention by letting each student have two votes (for 500) or one vote each for the 1,000 person simulation. The large simulation is closer to reality but much more difficult to arrange. We do it every four years at Westminster College, but we need at least six months to prepare, and spend over $ 5,000, mostly on the physical facility used to make our gym seem like a convention hall. The inexpensive short form worked well in Venezuela.

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The POLIS methodology for distributed political gaming via computer networks.

I Introduction

Political gaming has not been closely associated with computers. In fact, some researchers use the term "all-man simulation" synonymously with political gaming, emphasizing that no computer is involved. Political gaming originated with a group of analysts who were concerned primarily with the practice of international relations. These were policy oriented people. Their goals were usually analytic; at times they were normative. They were more interested in understanding particular situations-- sometimes actual, sometimes hypothetical-- than they were in discovering scientific generalization. Their work was essentially idiographic, not nomothetic. Their methods stressed the concrete, not the abstract, and policy relevance more than theoretical import. Whereas others-- call them the "simulationists"-- worked with models, this group attempted to capture more of the complexity and subtlety of international political issues through the use of fairly detailed scenarios, which focused on present or future, real or plausible policy problems. Country teams were often staffed by foreign policy experts and area specialists.

Sometimes, high level governmental personnel took part in the games. Their decision alternatives within a game were constrained, not by the rigid input requirements of a computer based model, but by judgmental considerations of plausibility.
They have been called "free-form" games for the reason that the choice of decision-input variables is large and unprogrammed. There are as many variables as the participants consider relevant; although the participants may not think explicity in terms of them as such. Plausibility judgments, as well as simulated responses from the environment (as distinct from other participating nation-teams) were provided by another group of foreign policy experts who constituted the "Control Team". The scenarios tended to focus on international crises. The games were played for periods of varying length; but an entire game seldom represented more than a few weeks of actual calender time, during which most of the variables at the system level of analysis were assumed to be relatively unchanged. Variations on the all-man game paradigm came to be used rather widely in the research and development community, in the United States Government's national security policy community, and in academia.

Man-machine simulations (or man-model simulations), on the other hand, cast the computer in a central role; although the term came into use in international relations before the models were actually programmed for computers. The main idea is that an explicit algorithm is employed. In these international relations simulation exercises, human participants provide inputs representing governmental decisions, which cause changes in a simulated national and international system. In some instances, these man-model simulations have employed a single decision-maker interacting with the model.

In others they have involved several nation-teams interacting with each other and with a computer-based-model. The models were often deterministic; although they sometimes permitted the interplay of random variables. In most cases, the models were essentially a priori constructions, resting on casual empirical assumptions. The variables and parameters rarely mapped easily into existing empirical databases. Typically, "arm-chair" empirical data were used to initialize the model. The model was then computed through a predetermined number of cycles (in the manner of iterative solutions of difference equations).

Much of the thrust of the efforts with man-machine simulations in international relations was social scientific in spirit. The goal was the development of a body of explicit, systematic empirical theory. Scholars like Guetzkow, whose work on the Inter-Nation Simulation had so much impact on subsequent developments, were interested in the development of a reliable and valid experimental tool (Guetzkow, et.al., 1963).
Replicability was essential to this purpose. Thus, political gaming, which produced something akin to case studies (dynamic case studies), was not suitable methodologically. The emphasis in this work was on systematic modeling of the decisional environment for participating decision-makers. It was essentially a nomothetic enterprise.

A statisfactory synthesis of the political gaming and man-model simulation perspectives has yet to be offered. Nor is that my purpose in this paper. Here I will simply point out that both approaches involve communications among human participants and that recent developments in interactive computing have created an overarching use of computers for both political gaming and simulation.

This is the use of computer-based, human communications networks.

To my knowledge, Shure and his associates were the first, in 1969, to use a terminal commucications system under computer control for all of the communications in a political gaming exercise (Shure, 1969). For Shure, whose interests were scientific and behavioral, the communications among the participants in a gaming exercise constituted *data*. But, these data have been notoriously difficult and costly to transform into a form that is amenable to systematic analysis and interpretation. It was Shure's idea to restrict inter-participant communications in political games to typewritten messages, the typewriter being a computer terminal. What was lost in naturalness would be more than offset by the gains of a machine-readable game transcript. This meant that content analysis programs, such as the General Inquirer, could be used in the "data-making" process. A computer, then, became a medium for human communications, a very different use than the usual application in modeling simulated environments. Several computer-based political gaming exercises were run by Shure and his associates at the Systems Development Corporation. Terminal communications software had been written for the Q-32 computer, one of the first time-shared computing systems.

The present writer worked with Shure on the above project. The idea was interesting: once all inter-team communication was channeled through a time-shared computer system, the locations of the participating teams became virtually irrelevant. They could just as well be spread across the country as in the next room. Thus, beginning in 1969, I initiated a series of trial-and-error experiments in "distributed policical gaming".

Not long thereafter, it was necessary to undertake the development of new computer software tailored especially for communications within distributed political gaming exercises;
The Q-32 was dismantled in 1970. Only later did I learn that computer scientists, beginning at about the same time, had been developing the field of "computer conferencing" and that our "POLIS Network software was very similar to their computer conferencing systems.

II Some simple pilot exercises.

The earliest trials of distributed political gaming exercises were rather primitive. Participating nation-teams consisted of students at UC-Los Angeles, UC-Santa Barbara, UC-Riverside, and California State University at Chico. The scenario was an adaptation of a nuclear proliferation theme set in the Middel East, circa 1973. It had been written as a part of Shure's project by Harvey DeWeerd of the RAND Corporation. Typically, the participating nation-teams were Israel, Egypt, the United States, and the Soviet Union. Control Team functions were performed by the author at the POLIS Laboratory at UC-Santa Barbara. These trials usually involved one turn-around of messages per day. An exercise typically lasted about two weeks. However primitive these early trials were, they nonetheless removed any doubt about the basic feasibility of distributed gaming exercises. A great deal of additional research and development work would be needed, to be sure. But it was quite clear that the dynamics of interaction, while altered by the new medium, were not distorted by it. And, the additional element of inter-location competition added something totally new to the drama of political gaming exercises.

In 1970-71, a new Middel East scenario was employed, and the POLIS Network games were moved onto our new PDP-11 minicomputer using "home grown" POLIS Network software. The list of participating institutions included UC-Santa Barbara, Stanford University, Cal-State at Chico, UC-Los Angeles, and UC-Berkeley. In subsequent trials, successively more advanced versions of the POLIS Network system were used, and each exercise ran over a longer period of time.

III Experimenting with greater complexity.

In 1972, a new approach was tried with the scenario. The present writer had long felt that the "crisis game" format which had been used until then was too narrowly focused. In addition, it would be interesting to learn whether a non-crisis scenario would be "playable". Most diplomacy, after all, is not crisis diplomacy. Could a diplomatic exercise be both absorbing and dynamic and not be dependent on the use of gimmics such as unexpected deaths, acts of nature, and other fortuitous events to impel action? Furthermore, could the single-issue focus of the typical crisis game be broadened to include a modest set of criss-crossing issues? If so, issue linkage could emerge in the bargaining process, adding appropriate complexity and realism. Crises could still be included, but they would be crises posed Within a dynamic context, not in abstract isolation.

A "multi-polar world" scenario was written in 1972, as a first step in exploring these possibilities. It was relatively complex, involving an "ecology of overlapping games" (the phrase is Norton Long's). Each subgame focused on a different geographic region or global issue.

Each nationteam was cast as a player in two or more of the different subgames. This scenario structure was intended to exemplify changes in the structure of the international system as it emerged from the post World War II era into a new era characterized by more complex distributions of power and control over resources. In contrast to our usual four nation design, the multipolar scenario was designed to pose meaningful foreign policy problems for from eight to twelve participating nationteams.

To date, colleagues from 33 universities in the United States have taken part in 14 distributed political gaming exercises using the POLIS Network system. Many of these schools have been in California. But, especially in the 1972-74 period, there was considerable participation by institutions from the Middle West and the Eastern Seabord (at that time we had access to low cost data communications lines).

IV An experiment in global gaming.

In 1973-74, three foreign institutions participated in a distributed political gaming experiment. A rather primitive patchwork among three computer networks was used. There were twelve nation-teams. Nine were located at American universities; the Benelux countries were represented by students of Professors Philippe Wilmes and André Frognier at Louvain; the United Kingdom was represented by students of Professor David Thomas at Southampton University; and Japan was represented by students of Professor Shinkichi Eto at Tokyo University. The exercise was conducted in English. Is was not without its problems, especially minor technical difficulties and problems of coordinating schedules across many time zones.

But there were no insurmountable obstacles. Experience was the main missing ingredient. None of the overseas teams had taken part in this type of political gaming exercises before, let alone doing so by way of intercontinental computer links.

International computer networks have expanded substantially since 1973-74; and the costs, while high, are not prohibitive. A foreign group can participate in a 4 to 5 week political game for about 1500 dollars.

V Some research and development findings.

The experience described above has led us to a number of conclusions and hypotheses. In this paper, only two areas can be discussed: the interaction dynamics of distributed political gaming, and some organizational aspects of the activity.

5.1 Interaction Dynamics.

In the POLIS Network gaming exercises, there is a complete absence of face-to-face communications between the nation-teams (interaction within teams is face-to-face). All inter-team interaction has taken place in one of two ways:
either asynchronously, through the exchange of messages via "electronic mail", or synchronously, through real-time computer conferencing. For readers whose main experience with gaming or simulation techniques has been with fast-paced exercises where the interaction is face-to-face, the idea of relatively slowly paced, asynchronous interaction and no face-to-face contact between teams may seem unusual, if not down right objectionable.

The view is often heard that live interaction is essential: The participants become highly involved and animated. There is discussion and debate, confrontation and compromise. To eliminate this dimension from an exercise may be thought by some to be throwing the baby out with the bath water.

Clearly, our work is based on a different set of assumptions. The view represented above is often accompanied by a tacit assumption to the effect that face-to-face communications are the normal form in gaming and simulation, and, as such, they require no methodological justification. This view is implicit in many educational applications, where there is no interest in collecting interaction data. But in terms of process validity, this assumption is surely not beyond question.
In international relations gaming, which was one of the earliest fields, the face-to-face custom actually emerged later, as the technique came into widespread use. The early work by the "founding fathers" all stressed written communications. I would argue that the uncritical acceptance of face-to-face communications for all purposes in gaming and simulation exercises can be both seductive and unproductive. In educational circles where "turned on" students have been all too rare traditionally, the small-group dynamics of the game room are often mistaken for representations of complex political interaction processes.
Similarly, stylistic similarities and the use of the appropriate vernacular by participating students all too easily mask substantive dificiences. Animated spontaneity, while a delight to many instructors, may not in itself be evidence of meaningful intellectual activity.

These tendencies may be understandable. In comparison to the hustle and bustle of face-to-face interaction in the game room, a group of students sitting with their writing and their thoughts may appear dull indeed. In a sense, interaction is the only "action" in an exercise. But this in an artifact of the observational method. On the face of it, it is difficult to distinguish idleness form thoughtfulness, or doodling from diagraming. It is understandable too that undergraduate participants may seem to thrive on face-to-face interaction. The informal small group is their natural habitat; they have little experience as professional "international relators". They are often impatient with having to formulate their positions in advance and to set their statements to writing.

Many instructors simply find it easier to permit relatively free face-to-face communications. Alternative communication rules are difficult to enforce, especially the requirement to do everything in writing while one is in immediate proximity to the other paricipating groups. If such rules are enforced, the resulting volume of written materials can be nearly overwhelming. Yet, for educational purposes as well as for research and analysis, a written record is a most valuable component of the gaming experience. And, from an educational point of view, it is surely to err in the direction of oversimplification to allow students to conclude tacitly that most political communication-- especially in international relations-- is comparable to an informal chat.

Every communications medium introduces its own influences, to be sure. But our experience suggests that the characteristics of computer-based communications tend to enhance international relations gaming exercises in at least two senses.

From a social psychological point of view, regardless of outward dissimilarities, this form of interaction has greater functional isomorphism than free face-to-face communications. At least this appears to be true for exercises in which students (non-professionals) are the players. The requirement to write everything contributes to a heightened sense of awareness of the problematic aspects of political communications themselves. This augments the usual student preoccupation with substance alone.

In the process, behavior tends to be a great deal more thoughtful and less impulsive.

From a practical point of view, the asynchronous exchange of messages has turned out to be very useful in the typical educational setting. Students may enter and leave the game at will between weekly or biweekly team meetings. Participation can thus be worked into busy schedules with maximum flexibility. The method might also lend itself to participation by busy professional analysts. Problems can develop if the teams do not participate at approximately the same rate of interaction (e.g., messages per day). Rough equivalence in message turn-overs should be maintained for most games.

Similarly, the frequency of use of the real-time, synchronous conferencing mode of communications may be an important factor. Disproportionate use of conferencing by subsets of teams can create serious sociometric imbalances. But, both the turn-over rate and the availability of real-time conferencing channels may be regulated by staff actions. Thus the tempo of an exercise may be fairly accurately adjusted to suit the purposes of the researcher or instructor.

4.2 Organizational aspects of distributed political gaming.

Since all of our experiments have been done in an educational setting using students as participants, these comments will have an educational orientation.

Most curricula in American universities include, in addition to general courses in international relations, specialized courses on the foreign policies of key nations (for example, the Soviet Union, the United Kingdom, West Germany, France, China, etc., etc.). Courses in regional subsystems are also fairly common (e.g., the international relations of Western Europe, the Middle East, Southern Africa, etc.). Also, there are usually courses which deal with selected issue in international relations (e.g., arms control, the so-called North-South dialogue, international trade and monetary and fiscal policies, etc., etc.). In any one academic term, only a subset of these courses can be taught.

Given considerations of size of faculty, estimated enrollments, faculty course-load and preferences, and curriculum balance; the latitude for coordinating some of the more specialized courses is not often wide. And, the chance of finding a group of faculty in the same department who are all willing and able to become involved in the use of political gaming are negligible. Yet, great potential for curriculum enhancement lies in the possibility of articulating selected sets of specialized courses. There is a potential for educational emergence-- the appearance at a different level of educational organization of "wholly new and unpredictable characters or qualities through a rearrangement of preexistent entities".

Instructors whose students have participated in POLIS Network exercises have heard this theme repeatedly from their students, although in far less philosophical terminology. Among gamers, the term "wholistic insight" is often used to describe what is at stake for the student (Greenblat and Duke, 1974).

An example might help to illustrate the way in which cross-curriculum complimentary may be turned to advantage.
As was mentioned earlier, recent POLIS exercises scenarios have tended to stress systemic complexity-- to pose problems which the participants must treat in the context of other, related problems. Some of the subgames are geographically defined, dealing with the main issues of a regional subsystem, and some are defined in terms of issues which cut across geographical lines. Table I lists some of the possibilities which parallel one of the more interesting POLIS exercises of recent years. The listing of issue areas and the classification of players can no doubt be debated. The main point, however, is not these particular examples, but the range of educational possibilities that can be generated with nine interlocking subgames.

It should perhaps be stressed that most instructors who have joined in POLIS Network exercises have made participation an integral part of a course: Courses are built around the experience. Exact modes of class and team organization have varied from university to university. At UC-Santa Barbara the author has been experimenting with fairly elaborate intra-team structures in an effort to generate a bureaucratic politics simulation within the international relations gaming exercise. Other instructors have tended to operate with less formal intra-team structure.

The choice depends upon what it is that one wishes to stress in the course. But, with a given set of subgames and major issue areas, it is important to assure complementarity among specialities across nation-teams. A group of SALT negotiators on one side, for example, needs a roughly equivalent group of negotiators on the other side.

Thus, there is a close relationship between the way participating instructors may organize their courses and the way in which subgames and issues are drawn in the exercise scenario. This may be seen in Table 2, which shows a mapping of subgames and issues into a representative grouping of courses at various universities.

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Applications of SIR WALRUS - A policy decision game with a list of future research topics.

This paper consists of three sections. First, the major conclusion of this research are summarized with some suggestions for improving the model. This is followed by a list of possible uses of SIR WALRUS. The last section recommends several research topics.

A. Goals of Sir Walrus

To the best of my knowledge, SIR WALRUS is the first simulation game that has ever been developed to portray Third World modern public planning process *. The characteristics of the Third World centralized planning system is uniquely represented by this operational simulation gaming model. When it is played under optimal conditions, it provides a unique simulated environment for examining and critiquing Third World public planning process. The game incorporates three categories of characters: those who produce plans, those who consume plans, and those who observe the planning process. In the game session, the 15 characters act within role descriptions which establish their relative strengths and weaknesses as they exist in the real world. Each has a pre-determined amount of various types of power to exercise in the planning process.

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* This was confirmed at the NASAGA Conference in October, 1977, in Boston and at the more recent ISAGA Conference in July, 1978, in Lund, Sweden.

This paper draws conclusions from a validation study of several developmental runs and one optimal game session. The validation study, based on data collected from debriefing sessions and post game conferences, resulted in the following findings:

1) The anecdotal data collected offered significant evidence that a well-run session meets most of the research and educational goals discussed below.
2) Proper orientation is required for a satisfactory result.
3) To be fully effective, the game should be an integrated part of a course, not just and ad joc addition to the course.
4) Philosophical honesty built in a model creates a stimulating environment which the students acknowledge and learn from.

The limited experimentation allowed an evaluation of a variety of goals summarized als follows:

Teaching Goal: To teach significant aspects of Third World decision making structure and the prevalent competing development theories.

Educational Methodology Goal: To provide student involvement and creation of critical dialogue among participants as an important experience in planning education.

Player Attitude Change Goal: To change original assumptions regarding the planning process in Third World countries and acknowledge the critical role that the public must play in planning.

The degree of accuracy with which the game represents reality of Third World decision making structure requires a subjective judgment. Several game sessions were conducted in classrooms and in national and international conferences.

Those participants who had previous experience in planning in Third World countries viewed the model as an accurate representation of reality. For those with no previous experience the exercise provided a learning experience about significant aspects of the public planning process in the Third World. The critical dialogue established among the game participants allows a thorough analysis of the relevant issues among the prevalent competing development theories.

The game participants became highly involved in most game sessions conducted in the classrooms at Stanford and elsewhere. A post-game conference with the players of the February 5, 1978, game session provides convincing evidence that the students enjoyed the exercise and found it educational.

The players' original assumptions regarding the planning process also underwent change. Players became more critical about the role of the power holders and more sensitive to the need for public participation in the planning process.

B. Possible uses of Sir Walrus

SIR WALRUS can be used for a variety of purposes. It could be used by students, teachers, scholars, engineers, professional and business organizations, government and UN organization, voluntary and cultural organizations, and farmer and worker organizations. Below is a preliminary list of potential users and applications for the game:
1. User: High School Teachers (grade 12)
Purpose: As a supplementary teaching resource, the game can be used for teaching social science issues, including the problems of technological progress. The game will provoke discussion on socio-economic and political structure in Third World countries, such as the political elite, government bureaucrats, multi-national corporations and foreign experts.

Method: Students would be encouraged to participate in a simulation game workshop as a class project. When a group of students--preferably from mixed cultural backgrounds--decide to play the game, the instructor will assign them to the roles of various characters, talk to them about the socio-political problems in the Third World countries, and provide essays and articles as supplementary readings. The instructor will encourage the students to discuss the subject with their parents and friends in order to prepare for the project. Following the game, the instructor must hold a debriefing session to permit free exchange of student ideas and reactions to the game.

2. User: Faculty members in universities and research fellows in research institutions.
Purpose: As a supplementary teaching resource in undergraduate and graduate courses or in special seminars, the game can be used in a wide range of subject areas such as economic development, public work projects, engineering management, water and land resource planning, rural development, and international business management. The game can also be used in some political science, education, anthropology and sociology courses. The instructor can use SIR WALRUS to open discussion on a wide range of issues: the socio-economic characteristics of societies in the Third World, the government decision-making process, problems of planning under dictatorship, the role of bureaucrats, the role of local and foreign experts, the role of multi-national corporations, technology transfer, etc.
Method: Three alternative procedures for conducting the game sessions are proposed.
1) The instructor will consider the game as the core of the course and will prepare the students for the game session well in advance. The instructor, for example, can assign the students to their roles at the beginning of the quarter or se-

mester. The students can be asked to conduct research about the character they plan to play in the game. The instructor may provide supplementary reading materials and invite guest speakers to provide information to the students on the subject. Then students are to refine the existing role description and begin to identify their allies and develop their own strategy to be followed in the game. They may organize brainstorming sessions to develop new scenarios or policy options. They may feel that the decision power allocation is not quite how they perceive reality, and thus they can modify chip distribution. A game session of about 12 or 16 hours can be conducted during one weekend toward the end of the quarter or semester. This alternative would naturally provide an ideal condition for conducting a fruitful game session and would allow for a validation study of the exercise.

2) The instructor will announce the game as an addition to the course and will ask for interested participants for a long session simulation game exercise of about 5-6 hours. The instructor can organize an orientation session for one hour a few days prior to the game sessions and distribute the game materials among the students. The students will then participate in the game session with moderate preparation. There is usually some time for a debriefing period in which the instructor can exchange ideas with the students on the subject matter. This is the second best alternative.

3) The instructor can devote a classroom session of no less than two and one-half hours to the game. The students will receive the game materials during a preceding session. The students attend the regular class and play the game. This alternative does not allow sufficient time for debriefing discussion, nor does it allow for the conduct of more than one round of play. This is the least optimal alternative for college classroom use.

3. User: Managers and engineers of public works projects with-

in the UN family or with a government organization in the Third World.

Purpose: The game can be used periodically as a supplementary training device in a staff training program or for organizational review and redesign. The game session will create a basis for dialogue and a better understanding of the problems related to the centralized decision making structure. The manager of a Third World organization might use it as a medium to facilitate communication, while the UN organization can use it as a medium to expose their employees to the Third World planning situation prior to overseas assignment.

The game session as a brain storming process might enable participants to study the most crucial issues and to discover solutions. The game session may result in a reorganized decision hierarchy to increase work efficiency, or improved skills of the young engineers in professional negotiations with foreign experts and members of multinational corporations.

Method: Timing is very important for the conduct of the game. The manager of a public works project may decide to conduct a game session at the beginning of project planning or in the middle of the planning process. There is usually no need for supplementary reading. The experts are simply invited for a workshop to exchange ideas and to offer suggestions. The game materials should be distributed in advance and at least one full work day needs to be allocated for the workshop. The workshop should be seriously evaluated by a team organized by the employees themselves.They may decide to invite a faculty member of a local institution to join the evaluation team.

4. User: Planning directors of multi-national engineering or construction companies sensitive to the problems of modern technology in the Third World and the critical role to be played by the population.

Purpose: These managers may find that an appropriate use of the game could sensitize the engineers and management involved in overseas assignments to develop new attitudes and values about the applications of technology, foreign expertise and investments, the participatory role of local experts and the public. Middle management and foreign employees may realize the negative implications of their work and redesign their role in Third World development.

Method: The manager may first want to prepare the engineers and the upper management for the game. For example, professional organizations such as the American Society of Civil Engineers (Civil Engineering, August, 1978) have discussed a new approach for project design and implementation in the Third World countries with a lecture series addressing the issue of reorganization and redirection of effort. The game session can then be proposed as a workshop on "options for project planning in developing countries". The manager must chair an orientation session and assign roles and distribute the game materials in advance. He may invite several local intellectuals active in the project. At least one full working day should be allocated for the workshop. The manager will lead a discussion during the debriefing period on how to employ ideas generated in the game to actual overseas operations. The manager may find the consultation of a faculty member from a local institution of help in the conduct and evaluation of the workshop.

5. User: Voluntary and professional organizations.

Purpose: The organizations may use the game as a medium for conveying relevant information about the Third World planning process to the general public and professional members in the community. Independent advisory committees among community members can be formed to provide input to the project.

Method: When the international division of a voluntary or professional organization sees the need for public involvement in a issue, they can incorporate the game session as an educational and motivational resource. The game session can be set up as a single event but it is more beneficial when it is incorporated in a two or three day program. The occasion usually does not allow enough time for a separate orientation session, but instead a brief, 30-minute orientation session can be held as the game materials are distributed. The workshop participants are usually from a wide range of professional and socio-cultural backgrounds. There is usually very little time for an evaluation study of the workshop but the debriefing should allow some feedback from the players.

6. User: Researchers in many fields including political science, education, engineering project planning, economic development, anthropology, communication, sociology, and rural development.
Purpose: The researchers from these fields can use the game as a research tool in a wide range of research programs: government decision making process in the field of development planning; simulation gaming as a technique to facilitate communication; simulation of social and political formation in Third World following land reform progress and the green revolution; simulation/gaming as a public participation tool for organizing public involvement in planning; the use of SIR WALRUS as a base for developing simulation games to portray government decision making process in the U.S., Russia, China, and European countries; the use of SIR WALRUS to study technology transfer among developing and developed countries.
Method: The research program would require the conduct of a series of game sessions either in a closed research setting (i.e., in a government bureaucracy or in a farming community. Spectators would naturally vary according to the scope, objectives and budget constraints of the research. Validation and evaluation study in these areas is a fascinating field that should attract interested researchers in the areas of planning and simulation gaming.

7. User: Grass roots organizations.
Purpose: Play and social drama have been used in the past (especially in the People's Republic of China) to strengthen the peasant and worker movements in society in order to achieve social justice and liberation. Grass root organizations in the Third World might use the game as an educational tool to demonstrate many contradictions that exist within the governments' decision making process. They can increase their organization's strength by practicing struggle in a gaming context.
Method: With serious modifications, the game can be related to a real context of resource allocation process in a community. The game materials must be mostly presented to the community members verbally. Perhaps several experienced players can be introduced to the game in advance to assist other players. For example, a farmer grass root organization may study the issue of equal water distribution in the community in a more concrete fashion by playing the game. During the play the game allows a safe form for collective action and intervention, and permits the farmers to try out possible courses of action. The potential of this technique has not yet been explored. The users of the model in each context can undoubtedly develop their own innovative approach.

C. Future research

The following are several future research projects that can be pursued as spin-offs to SIR WALRUS:
Improvement of the Model
Adaptations of the Model to Different Countries
Validation of the Pedagogical Value of the Model
Simulation/Gaming Theory: Test of the Value of Extensive Role Descriptions
Philosophical Honesty in Simulation/Gaming Design
SIR WALRUS as an Aid in Decision Making.

1. Improvement of the Model.

SIR WALRUS is a new simulation game. There naturally is room for improvement. Further research and development of the game can be carried out in the areas of design, validation study, and administrative mechanism.

1) Design improvement.

New Characters: The real world of Third World public planning process involves more characters than those now identified in the game design. For example, various U.N. agencies, voluntary organizations, and the mass media play important roles. The game may more comprehensively portray the real world if these organizations are represented. The present design thus may need to be improved by further research. For example, role descriptions for new characters representing voluntary organizations and the mass media both at national and international levels need to be developed. These characters can play observatory roles with different degrees and types of power. A new character might also represent the United Nations Development Programme Resident Representative as a member of the plan producer group.

Scenario: The present scenario, which focuses on a water development project, may not interest all the potential users of the game. However, the game structure can entertain a wide range of scenarios--such as community land use planning, large scale water development projects, options in rural development, selection of national priorities, development of peasant organizations, etc. Further scenario development is an important area for improving SIR WALRUS. In fact, following the conduct of game sessions on several occasions, the players themselves came up with some suggestions for new scenarios. At one point a player suggested that the game could accommodate a social revolution scenario! Another player commented that the game can be slightly restructured to portray a major industrial development planning process. The scenarios need also to be supplemented with appropriate background information.

2) Validation Study.

The validation approach developed in this research can also be improved. My critical review of the validation literature was presented to several game experts in the U.S. for review and criticism.

As of the writing, their feedback has not been received. Also, two other areas require further elaboration: the use of sociodrama design as a referent system to explain competing development theories, and the comparison of the game events to the referent system as part of a validation mechanism. This approach requires fellow scholars' critical examination and input for improvement. Furthermore, the validation methodology adopted here which relies on follow up interview sessions with the players needs to be tested under different conditions.

3) Administrative mechanism.

Game Material: There is too much reading involved on the part of the players. An innovative approach to introduce the players to the game materials is required. In the past, group orientation sessions turned out to be a success, but were time consuming. Development of a 30-minute supplementary slide show might help to orient players to the game materials and procedures. Some editorial improvement, better printing and better presentation format might help the players to read the game related materials with more interest. For example, a summary note on the basic rules and the use of chips can supplement the detailed rules of the game.

Game Accounting: The present game accounting system is time consuming. The game needs to be stopped for 15 minutes prior to a new round. New procedures need to be developed so that part of the accounting can be done by the players themselves as the game session proceeds. In the conduct of the game session, the game director holds a lot of responsibility. The refinement of the game must improve the game structure so that the director's role can be reduced to that of facilitator.

He/she must only be a resource person, not a "decision maker" for leading the game. A new resource manual must be developed to provide answers to a series of predicted questions. The game may need to have more than one game facilitator. They themselves must have a role description to detail their tasks and duties.

The Game Room: A large conference room has been used as the game room in which each character uses a desk as his or her office. A redesigned layout would increase the possibilities for holding private meetings and negotiating contracts. Fifteen separate small rooms on one floor of a building might provide a better alternative if a long game session is planned and if more than two players will be representing a character. Bureaucratic restrictions and physical limitations can be realized in the design. For instance, to have a meeting with a power holder, characters such as the farmers may have to acquire certain chips from the facilitator.

2. Adaption of the Model to Different Countries.

Research can be conducted to adapt the SIR WALRUS game framework to the distinctive decision power structure of various countries. The conclusion of this research might demonstrate the applicability of SIR WALRUS to the planning operations of many nations both in the developed and the Third World. First, a research team is required to collect information, conduct field surveys, organize seminars and interview experts in related fields to develop role descriptions for various characters involved in the real world planning process in these countries. The team can then decide to reallocate "decision power" in the form of varying numbers and different color of chips. Naturally several trial runs would be required to finalize the design. A nucleus group of game participants needs then to be organized. The graduate students in a planning program for one term, or the staff members of a planning division in a research institution, might serve such a need.

They would play the game several times under different sets of redistributed decision making powers and with different role descriptions, according to the preliminary research. For examples, one researcher may decide to conduct the game session with four different kinds of decision structure to represent countries such as the U.S., Russia, Tanzania, or Japan and then analyze the process of decision making as well as the outcome.

When a workable adaptation has been developed, experimentation can be made. A large class, i.e., 100 students, in a university could be divided into four groups to play the game using the dicision structures which have been developed. The students could participate in a joint debriefing period to discuss their experiences. This research might be repeated several times in order to allow the collection of data for an evaluation.

3. Validation of the Pedagogical Value of the Model.

1) There is a need for further research to evaluate the contribution of SIR WALRUS as a supplement to the conventional classroom lecture for teaching public works planning at the university level. It may be proven that a simulation gaming model such as SIR WALRUS should be used as an important teaching supplement in public works planning courses.

Students registered for a big public works planning class might be randomly divided into two groups. One group can be taught using only the conventional classroom lecture methods; the other group can be taught by using the game method in addition to the simulation game, SIR WALRUS. Several game sessions of SIR WALRUS could be conducted during the course and students would be encouraged to write essays about their game experience. At the end of the course the two groups of students can be tested using a unique evaluation program. The criteria for such an evaluation would include knowledge about the subject matter, student involvement in the process of teaching and learning, attitude change about the decision structure, the role of citizens in society, and the role of technology. This research requires repeated experimental sessions in order to validate the game's usefulness as a pedagogical tool.

2) Research can also be conducted into the potential of SIR WALRUS for teaching U.S. and European high school students about the Third World. Perhaps high school students can gain better insight about the reality of socio-economic and political formation of the Third World countries and the nature of interdependency of the world economic system.

The uniqueness of SIR WALRUS is that is presents the contemporary decision structure of the Third World as it relates to the role of the local elite in conjunction with the multinational corporation and the foreign experts. The criteria for success would be twofold: the amount of material learned and retained, and positive attitude change.

4. Simulation/Gaming Theory: Test of the Value of Extensive Role Descriptions.

Because of the extensive role descriptions, SIR WALRUS has been considered by many experts as "innovative" in this regard. A study might be conducted to test the value of the extensive SIR WALRUS role descriptions. Such research might provide evidence that in a social science game, role descriptions will better involve the players in the game session and offer better insights into the societal context being simulated.

The research methodology would necessitate the conduct of two game sessions with two similar groups of players, one group would not receive the present extensive role descriptions.

A careful evaluation mechanism would be developed to investigate the differences in the knowledge of the players as well as their game behavior. Individual follow-up interview sessions might allow for direct feedback from the players. Several experts might also be invited to observe both game sessions and comment on the processes and outcome of what they observed.

5. Philosophical Honesty in Simulation/Gaming Design. Traditional simulation gamers have claimed objectivity, but are obviously biased and have built their models around the subjective interpretation of the reality to be simulated (See my review of validation literature). In the design of SIR WALRUS, realism has been considered as justification for the game. An attempt was made to assure that SIR WALRUS does not contain "hidden theoretical biases" nor does it depend upon "an abstract system of reference". The variable aspects of the reality of Third World planning are explicitly represented in the game structure and process of play. However, the utility of the model as "a producer of knowledge, or a reproducer of knowledge in the pedagogical sense and as an aid in decision making" requires further research.

This would require further effort to establish more dialogue among the gamers and philosophers. The field is new and it requires more basic research.

In conducting further research in this regard, a researcher must first increase his/her command about what exists in the market and objectively classify several social science and planning games. Having achieved a good knowledge of the subject, an opinion survey questionnaire must be sent to educators who oppose the use of simulation/gaming as a pedagogical and research tool. Their opinion about the value of selected simulation games must also be acquired. This survey would allow a first hand synthesis of the opinion of opposing views on the use of simulation gaming models. Later, several of these educators need to be encouraged to play and observe SIR WALRUS game sessions. Their opinion about the new game experience must be analyzed. Furthermore the researcher must organize conferences on the subject by inviting the representative groups of people who are for and against the use of simulation/gaming in order to clarify the fundamental disagreement and where the SIR WALRUS model fits in this scale. The researcher himself might also compare the process and outcomes of an existing planning game with SIR WALRUS by asking two groups of players with similar backgrounds to play the two games.

6. SIR WALRUS as an aid in Decision Making.

The potential of SIR WALRUS as an aid in decision making process in an international development program is an interesting area of research. A researcher must be able to persuade a planning organization within a country in the Third World to allow an experimentation of SIR WALRUS as an integral part of a development planning process for at least one year. The researcher needs to develop a program for the staff members to periodically play the game--especially prior to major decisions on development issues. The staff may actually be encouraged to change the game scenario into their real project scenario and make decisions about a new set of policy choices within the gaming context. An evaluation mechanism is required to investigate whether the play of the game results in any changes in the kind of decision being made or whether it results in any changes in the organization design to allow a redistribution of actual decision power. The experiment may be conducted in the office of a multi-national consulting firm responsible for the planning and development of a significant project in a Third World country. Such research has two possible results:
1) to reveal the social and environmental values and prejudices held by the staff, and 2) to permit restructure of the organization to facilitate more responsive-responsible decision making.

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A participation procedure for a building project of a Pcgd-office at Leeuwarden.

This article will demonstrate how the employees of a large company participate in the planning of a new office building. The building process has now reached the contracting phase, making a first evaluation of the participation procedure possible.

1. The situation: The Clearing office.

Most account-holders do not know that a Giro clearing office exists in Leeuwarden; most of their contacts are with the clearing offices in the Hague and Arnhem. Nonetheless, the office in Leeuwarden is an important part of the Dutch Postal Cheque and Clearing Service (=Pcgd). The Giro clearing office in Leeuwarden is mainly responsible for the file maintenance (addresses, signatures, authorizations, etc.) of the account holders. A department for comsumptive credit of the RPS (State postal savings bank) is housed there too.

Some important characteristics of the clearing office in Leeuwarden:

- very rapid growth (set up in 1971 with 150 employees, now employs approx. 1200);
- relatively young employees (about 21 years of age);
- the largest department, about 600 persons, is divided into sections (of 20 employees each with supervisor), all performing similar administrative actions.

2. The building project.

All the operations of the clearing office now take place in a number of buildings spread in Leeuwarden, which has various drawbacks. This led to the decision to buy the area next to the main building, at the start of 1976. The new building was projected in this area, and is to be connected to the main building. The new building will have 16,000 square meters office space, giving office room for about 800 employees.

In a very early phase management expressed the desire to involve the employees in the planning of the new building. The authors (at the time both employed in the organization-development group of the Pcgd) were asked to submit a plan - formulated as a proposal - for a possible participative procedure.

3. The proposal.

In designing the proposal the following principles were chosen:

3.1 A minimal temporary organization: as much as possible should be done through the existing channels of decision-making.
This implied, among other things, that the employees themselves would not make decisions (see 3.1.1).

It was thought necessary to install two workgroups: A facilitating group and an information group.
Applying this principle in this type of project can lead to improvement of the quality of the existing consultation and decision-making procedures. The phenomenon of work consultation meetings by means of "group meetings" was greatly strengthened in this way.

3.2 The building process was still in the stage of formulation of wishes. This implied that the employees should be asked about their ideas, preferences, strivings and resistances.
It is definitely not necessary to work towards unanimity; on the contrary this would restrict the quantity and quality of idea-production.

3.3 The complexity of the subject (a new building) and the inexperience of the employees (and people in general) in building and architectural issues necessitate the use of symbols and the search for core themes (see 3.2.1).

3.4 The organization's management must eventually reach a unanimous and clear position based on relevant arguments. One may expect that those specialized in the field of building are able to translate the quality demands of the organization into architectural and constructional forms.

3.5 One may also expect that the employees do not want to talk about the new building only. It was known that employees had complaints and wishes about the existing offices as well as their work situation. The participative procedure should give ample room for ventilating these feelings and attitudes as well.

Of course, things which are experienced as positive were also of interest to us.

3.6 Do not ask for more you can bargain for, nor promise more than you can deliver:
We were warned by various people about participative procedures which started full of high expectations and culminated in general frustration and disappointment.

3.7 A building project like this takes years of preparation and execution. Builders themselves distinguish a number of phases in a building process, each phase characterized by a specific goal, time dimension, "roles" of concerned people, etc. Essential in this is the irrevocability of most of the decisions made earlier. This irrevocability necessitates some very clear elements in this particular participative procedures: All the employees should be well-informed about "the essentials in this phase" and "the essentials in the next phase".
We used the following phases:

- an intention:"we want to build"
- study of feasibility: "is there money, ground, etc."?
- the "user" makes a list of demands (size, qualities, dimensions, etc.)
- a temporary design: the building team translates the list of demands into sketchy designs
- the definite design
- the complete blue-print for the construction
- inviting tenders for conctracting
- execution of the design
- building becomes ready to use.

In our opinion items 3.1 and 3.3 are very important, and are examined more extensively in the following parts 3.1.1 and 3.3.1.

3.1.1 The development-organization and organization-development.

In order to create changes in an organization temporary organizational forms (like workgroups, committees) are frequently used. When a change is of a large and important nature then models of project-organizations are often used in medium-sized and large organizations.
The project-organization is then seen as an adequate means to attain the desired goal with limited manpower and limited time.(1)

For organization-development agents the project-organization has very specific advantages, apart from its general advantage of a temporary concentration of manpower and means:

- the client-system becomes clearer because it is restricted to the temporary organization. The organization-development agent is usually equipped for working in small groups and usually feels more at ease in face-to-face relationships.
- a temporary decrease of restricting influences within a project-organization can more easily lead to a different kind of working climate and culture (more open and egalitarian). One hopes that this will work in a normative way towards the standing organization.
  Project organization then becomes a good method to unfreeze a solid situation.

But the advantages of temporary organizational forms like project-organizations, carry with them, simultaneously, disadvantages for the organization-development agents:

- The people, means and conditions required only become available at the cost of the standing organization. In this sense stress always remains between the project-organization and the standing organization. Giving more resources to the project-organization implies less for the standing organization, and the opposite implies a smaller developmental impact.

- In conjuction with this, another disadvantage lies in the inclination to add more staff-personnel to the project-organization to lessen the stress. The nature of their jobs facilitates a temporarily less frequent presence in their offices. A project-organization then increases the gap between line- and staff-personnel.
  Additionally, few key-persons will participate in the project-organization, which does not help in implementing the results.

- The conditions for working together in a project organization usually differ greatly from the standing organization.

The organization-development agent will quite often feel successful during the initial phases of a project.
The growth towards more open, more egalitarian cultures, specifically occuring in o.d. projects, can easily lead to a situation in which the project-organization begins to "lead its own life". The participants feel themselves more attracted to their role in the project organization than in the standing

organization in which they do not actualize themselves as much. The existence of the project-organization becomes a goal itself, and participants are very inclined to identify themselves with it.

To the extent the project culture moves away from the other culture it will become more difficult to transplant its culture to that of the standing organization. For non-participants the gap becomes un-bridge-able. The participants themselves will feel "put back" when the project is finished.

Next to the above-mentioned, it remains questionable if a culture which is adequate in a project structure is by definition also adequate in the standing organization, which is formed on a basis of different criteria and different development processes.

Conclusion:

We have the impression that too often temporary change-organizations are implemented, especially in organization-development projects, without sufficient consideration.
In contrast, we prefer utilizing the standing organization as much as possible for organization development goals.

Temporary structures in general only appear adequate for developing self-renewal capacity, while renewal potential must develop eventually within the standing infra-structure.

The project discussed here was an attempt of ours to maximally utilize the infra-structure of the standing organization.

3.3.1 Laymen and experts.

Some of the focus points in part 3.3 were:
- level of influence
- kind of influence
- terminology.

Level of influence.

A potential pitfall in participation projects is the inclination to give laymen very marginal room for influencing and on a low conceptual level, mostly in the area of concrete operationalizations. The reason for this is the inability of laymen to think and cope with the concepts and in terms of the experts in the field. There is a large chance that laymen themselves experience this as a triviality, or that the expert, not liking the chosen solution, will use his expert-power to push through his solution anyway.
It is on the concrete level, the operationalization level, where laymen are no match for experts.
In order to make influencing attempts of laymen more effective and more meaningful for both laymen and experts, laymen must be able to participate on a policy-level: a level on which guidance can be given to the creative work of the expert.

The laymen should not be placed under the expert but above him!

Kind of influence.

Diversity, strivings, no decision-making.

It is essential, in our view, not to work towards decision-making by laymen, at least not in a phase in which experts must still work.

All the relevant factors for a balanced judgment cannot be handled by laymen, anyway. Even more so, and probably of more importance, the forming of opinions can now take place more freely. In this way there is much more room for bringing forth a diversity of opinions, for expression of strivings and the underlying attitudes in a group meeting.

This gives the expert meaningful information without restricting his creativity.

Terminology.

In order to facilitate laymen in thinking about specialistic work on an intentional level, on a policy level, some special demands must be made of the means of expression to be used.

Abstract concepts which can have a world of meaning in a field of expertise, can be practically void of meaning for non-experts, or give irrelevant associations.

This problem can be tackled along two lines:

1) by using, where possible, visual or physical symbols. These have the advantage that laymen can more easily cope with them.
2) by letting the terminology and symbolism be colored, or even more so, be determined by the experiential aspects with which laymen identify

themselves and which they experience.

This of course requires a preliminary reconaissance of each field situation, because use of a standard symbolism is hardly possible, and should at least be tested on validity.

4. The plan for participation.

In October 1976 the proposal was discussed with management and high echelon supervisors of the clearing office in Leeuwarden.
After some amendments the proposal was accepted. In designing the proposal we tried to describe exactly how we intended to work.
This had the advantage that it was very clear what was being accepted. Afterwards, the disadvantage of such a concrete and clear proposal became evident: the proposal was used as a blue print making changes hard to accept.

4.1 The contents.

In February 1977 no less than sixty sections held meetings lasting a morning or an afternoon. Beforehand everyone was informed about the goals and procedures of the meetings through two "building newspapers".
The meetings were held along a previously set program which was tried out first (see appendix). The supervisors acted as leaders of the meeting; when necessary they were assisted in this by colleague. The supervisors had had a day to exercise and become familiar with the program and their roles.
Minutes were kept of each meeting making a comprehensive report possible of the meetings as soon as all had taken

place. All reports were public, including those of the consecutive meetings held in the rest of the organization.

4.2 The meetings.

The following was characteristic of the meetings:

- means: a large meeting room with enough chairs, no tables, about nine large tackboards (50 x 125 cm), covered with sheets of brown wrapping paper, marker pens, colored stickers, card pins and a container of coffee (self-service).
- method: using brainstorming (writing wishes, complaints, quesions, etc. on cards and tacking these on the boards) to come to a richly diversified answer to questions concerning:
  1. how the existing office housing is experienced?
  2. all the things one does daily ("work" as an answer is a most obvious one but talking, reading the papers, dallying - if one is honest - also belong to the daily activities).

The conditions of brainstorming were maintained as much as possible: more questioning (for clarification) than stating, and not working towards unanimity. What matters is diversity and pluriformity; what does not matter is "true of false", nor "smart or stupid".

The purpose of this part of the program was to familiarize participants with the method of working, consecutively thereby helping them "to get down to business": discussion of the new building.

As mentioned above, all were given information beforehand about, among other things, types of building (e.q. cubicles offices, garden offices) and the core themes of importance in this phase. These core themes were specifically the wishes/preferences which have consequences for the use of (office) space, that is, determinant for the total form and composition of the building.

The second part of the meeting was devoted to collecting and the representation (by using multiple item scales) of preferences in regard to the core themes. For example:

- I want the supervisor to have his desk in his section because..............; or: not..............because..
- If I want to go from point A to point B I want a variety in scenery/be able to choose various ways/ be able to choose corridors alongside or through other groups/go by way of closed corridors.

Finally, doubts and worries were asked about the participation project itself and other things.

Role of the supervisor.

Activating, stimulating, supporting and pursued questioning.
Specifically not: defense of the participation project or other situations in the organization. Any questions he could not answer sufficiently at that moment were recorded under the agreement that they would return to the subject later.

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Project guidance.

An information group was installed responsible for making the building newspapers, an info-stand, etc. A facilitating group was installed, based on quality and range (persons of divergent ranks, interests, etc.). This group had the task of guarding progress of the project.
Members attended the group-meetings.

The sequel.

All reports were gathered into one overall report by the facilitating group. Mentioning of opposing views and divergent opinions was avoided. Again, goal was to collect reasons and argumentations. The designers would in due time come to the task of meeting the wishes but also the doubts.

Subsequently the overall report was discussed in the supervisors' meetings. The supervisors gave specific attention to:

- matters which should be given further elaboration (considered from the department view).
- matters which can be taken care of "right away" (and which do not have to await completion of the new building).

The supervisors then added their advice to the report. Their advice fitted in well with the trends of the group meeting, probably due also to their extensive involvement with the group meetings.

Finally, management determined its position. They reacted well-argumented to the statements of employees.

Here too a high congruence in opinions was apparent.

4.3 The result.

The procedure which was followed led to a list of demands, which was presented to the building team (architect, constructor, the central division of the PTT concerned with buildings, etc.). This list of demands had an advantage compared to the traditional technical listing (space division in sq. meters, etc.):
the architect is invited in this manner to give a qualitative explanation of his design.

The members of the building team were unanimously satisfied with the results. Qualitative descriptions were accentuated instead of concrete housing-regulations, thereby giving sufficient insight into the wishes of the users.
On the other hand, it gave the experts enough room to invest their expertise.

The results were integrated unambiguously in the temporary design. Employees were presented with this design using a dummy construction of a projected section, an introduction talk and a wall presentation. Groups of eighty employees at a time could acquaint themselves with the design. Since the architect, e.a., had in our view been very consistent in integrating the results of the participation he received only enthusiastic approval.

The definite design was solely presented in the information magazine, essential changes not being required.

5. A final note

PTT policy encourages involving artists to decorate and embellish buildings. Participation in art is a ticklish affair: more than any others art-professionals claim an autonomous working climate.
All the same, their products have great influence on the working climate for employees.
In order to let employees participate optimally in the artistic contributions a group was formed to comment upon and evaluate suggested contributions. In our view this is the most feasible way of reaching a form of dialogue between employees and artists.

The flaps which were used in the group meetings are presented as appendix, for the ISAGA-conference.

Appendix:

January	February	March
briefing supervisors	section group meetings	working out reports

Program

8.30 - 8.40	opening
8.40 - 9.10	the building you work in now
9.10 - 9.40	the things you do on a usual day.
9.40 - 10.10	where do you want.......
10.10 - 10.30	and then how?
10.30 - 11.15	conclusions
11.15 - 11.30	writing of report

or:

12.30 - 12.40
12.40 - 13.10
13.10 - 13.40
13.40 - 14.10
14.10 - 14.30
14.30 - 15.15
15.15 - 15.30

Rules

1. write it down
2. keep it short
3. not clear?   ask about it
4. what matters is collecting opinions, wishes doubts, etc.
5. you don't have to reach a group opinion.
6. what you do need:
   clear explanations:
   - I want this, because.........
   - I don't want this, because....
   - rather this than that because.
   ......

About the building in which I work now I find.............

good	missing	bad

What do you do on a usual day?

1	2	3
work	relaxation during working hours	meetings and educational activities

What do you do on a usual day?

4	5	6
study employee reviewing	putting away personal belongings	eat lunch long breaks

What do you want.......	1	2	3	4	5	6
at your own permanent place						
nearby, or a few steps away						
walk off, but ont the floor						
some place completely else, another floor						

1 2 3 4 5 6

makes no difference

cubicle offices	rooms office	garden office

one section to a room	everything

When I go from point A to point B then I want:

a variety in scenery	corridors alongside or through other groups	to be able to choose from different corridors	to go through closed corridors	makes no difference

Connections between floors (elevators, stairs)
I want:

centrally located	spread around a few places	spread around many places

6.5 Mr. F.P. Gout and mr. T. Janusch.

What kind of game should be built?

1 What is a game?

A game is a specific kind of simulation. So, before treating some of the methodological problems which stand in relation to the technique of game, we should first raise the question: what is simulation?

"Simulation is the transformation of a dynamic system into a dynamic model". This rather general definition should account for the various ways in which this research technique is circumscribed.

A system, or 'referent system', as it is usually called when it is the origin of a simulation model, is that part of reality the problem field refers to. By transforming it into a model, the scientist aims at usefully replicating the referent system. The usefulness of this replication is dependent on the problem definition: does it adequately reveal the relevant features of the referent system?

In this way simplification, abstraction, and selection are the essential characteristics of a model, dictated both by the problem definition and the problem field. The problem definition gives the criteria for the selection of certain common elements out of the totality of phenomena that constitute the referent system.

At the same time, the structure of the referent system, the relations which exist between those phenomena, has to be represented in a correct and clarifying way, must be abstracted and simplified.

Up to this point, a simulation model does not differ from any other model. The essential difference is to be found in the dynamic nature of a simulation model. Besides giving some insight into the structure of the referent system, a simulation model intends to depict its evolution, the course of the interactions between elements of that system in time. Simulation, therefore, especially should be judged by the following criterion:

To which extent does the simulation model succeed in representing the dynamics of the referent system while retaining the possibilities of a static model: controllability and verifiability?

The concept of game is associated with several meanings. The more common-sense use of the word implies any simulation in which a group of players represents (a specific part of) the referent system.

In his 'Simulation and Society', Raser uses the concept of game a.o. in a second, quite unusual way, wanting it to mean the development of a model from a mere tentative hypothetical view into a full-grown consistent model, based on a testable theory.

In this paper, we will use a third definition, which among simulation methodologists is acknowledged to be more exact than the first one mentioned above. In this view types of instrumentation of simulation are distinguished.

A computer simulation, being the only one of these three forms in which no human players are involved, intends to translate the working of a process into mathematical model. Relations among parts of the referent system are expressed in e.g. mathematical formulas. The easiest way to understand a computer simulation is to regard it as a formal version of theory construction. Observations and speculations about the mechanisms of the system in question are expressed in a formal language. The effects of the system parts on each other are imitated by specifying their interdependence in formulations like "if a = x, then B = y", and the historical process by inserting a time element: "if a = x at t, then b = y at t". The "zero situation" is created by giving each system part a certain value.

In two respects, the word 'computer simulation' is somewhat misleading.

A computer or any other piece of mechanical equipment might be used to achieve this goal, but this is by no means necessary. And although the model opted for generally is a mathematical one, this too is by no means necessary. Other forms of expression are equally possible. A pure man simulation or gaming seems, at first glance, to be the very opposite of a computer simulation.

Respecting a given set of rules and considering the roles the simulationist has ascribed to them, which generally include the goals they must achieve and the means by which they are allowed to achieve them, the players fully control the course of events without interference from the games management. Contrary to a computer simulation, a gaming has no fixed parameters to express the relations between some system parts. No reaction of the players on one another is prescribed by the rules of the game, leaving aside some formal rules, securing the progress of the game as a game.

The third from of simulation instrumentation is the man-machine simulation, which may be considered a mixture of the two other forms. In a man-machine simulation one part of the referent system is represented by the games management, who is responsible for the machine (computer) part of the simulation. The remaining parts of the referent system, usually being those parts which are under special consideration, are copied in the man part. The mechanisms of one part of the system or its behaviour in a special situation being unknown, it is impossible to 'programme' its reactions, to reduce them to fixed rules. Well, a man-machine simulation makes it possible to observe the behaviour of this part of the system, represented by the players, in its relation to the other parts, which are known and therefore can be simulated by means of a computer model.

In the following we will confine ourselves to these two variations of a gaming: the man-machine simulation and the pure game

2 What a game is built for

Among simulationists, there is a strong tendency to consider the choice between a man-machine simulation and a pure game to be dependent on the purpose the simulation should serve. In this paper we will try to show the relativity of this view. But, before elaborating this relation, let us first review the various functions of simulation.

In simulation literature it is the practice to distinguish three different functions of simulation.

Constructing a simulation game, and afterwards executing it, can be a useful device for the testing of theories. In modifying some of the values and/or parameters of an already 'proved' simulation, future developments may be predicted, or the probable effects of certain measures can be indicated. In this way, simulation can be a tool in policy-making.

And, last but not least, a simulation can be used as an instrument for instruction: the participants in a simulation game are dealing with problems previously unknown to them in a far more direct, practical, and palpable way than is possible with most conventional instruction methods.

On a different level, a second distinction is made with regard

to the relation a simulation has to its referent system. A replication game seeks to uncover the mechanisms which have produced an actual state of affairs in past or present. An optimalisation game, on the other hand, aims at discovering the decisive variables in bringing about some dessirable state of the referent system.
It is common use to consider this relation between a simulation and its referent system and the function of a simulation to be intrinsically related to each other. The function of pure theory-testing is frequently associated with replication, while in policy-making at least an element of optimalisation should be involved. And an instruction game, as is generally stated, should aim at a realistic replication of the system one wants the players to become acquainted with.

In this paper we want to present another point of view, stating that the man-machine simulation and the game rather differ in the degree in which they are able to meet the conditions of controllability versus dynamics and that, therefore, a choice between those instrumentation forms first of all should be viewed in relation to the choice for the priority of one of those two.
But, before elaborating this, let us take an example from the praxis of simulation and see how in this case the choice of the instrumentation from is related to the modelling. To that end, we take a game, developed by ourselves, the so-called SUS Game.

3 How a game was built

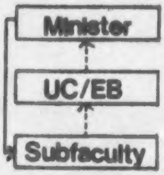
The problem-field of the SUS Game - "SUS" stands for the (fake) 'State University of Scienceborough' - was the functioning of a Dutch University Board with regard to the problems related to enrollment of students. Let us have a closer look at the problem-field, in order to be better equipped for the answering of the question which instrumentation form should be the most adequate.

In the late sixties, and the early seventies, Dutch universities, not unlike those in other countries, were confronted with two rather unexpected simultaneous developments, which can respectively be labeled as 'internal democratization' and 'external democratization'.

The student revolts in Paris, Berkeley, Berlin, and other major university centres, did not leave Dutch university life undisturbed either. One of the demands was for a new administrative structure, which should put an end to the management monopoly of the scientific staff and allow students to take an active role in administering universities. This call for a democratic structure resulted in the 'University Administration Reform Act' of 1970. This act gave birth to new governing bodies at the three different administrative units within a university: Subfaculty Councils, Faculty Councils, and, at the highest level of the organizational structure, University Councils, Subfaculties and faculties are responsible for education and research activities, and their governing bodies are chosen by and from the three groups within a university community: scientific staff, non-scientific staff, and students.
At least 50 pct of the Council chairs are reserved for members of the scientific staff, who are chosen from their own ranks. The same holds good for the remaining chairs, reserved for students and non-scientific staff members. University Councils (UCs) are responsible for the administration of a university as a whole. Having the same representation system as the Councils at the lower levels, an 'equal representation of the faculties' has to be secured as well. This combination of conditions for the distribution of University Council chairs has resulted in a voting system, under which the chairs are divided per group per faculty, and the future members of the

UC are to be chosen by and from these groups and faculties. Another body at this top level is the Executive Board (EB), whose relation to the UC is somewhat like that of a Government to a Parliament.

Something quite different, but probably not unrelated to this internal democratization, has been the explosive growth in the number of students, especially in the sixties, and its resulting consequences. Up till then, the Government traditionally furnished the financial means a university declared to be in need of. But, in the late sixties, the financial needs of the universities turned out to be irreconcilable with the priorities of the Government, and the automatism of giving the universities what they asked for was abandoned. This new policy culminated in 1970 in measures, by which the number of personnel was 'frozen', and no more investments were allowed. At the same time the universities were not inclined to adapt their educational programmes, while this had become necessary in this state of fixed means in order to cope with the growing demand for education.
This immovable situation resulted in the 'Students Enrollment Authorization Act' of 1972, which legalized the already existing practice at some subfaculties to put a limit to the number of students who could enter a university institute.
This act lays down the procedure to be followed for determination of the number of students a subfaculty has to admit.
The combination of the new organizational structure of a university - result of the 1970 Act - and this procedure as stated in the 1972 Act, gives the following simplified 'flowchart':



A subfaculty, being of the opinion it is confronted with too large a number of new students in proportion to its capacity, can apply for a so-called 'numerus fixus', a fixed number of students it has to admit. This decision, made in the Subfaculty Council, is sent to the EB, which, in this way 'having heard the Subfaculties', draws up a proposal, a recommendation for the UC. The UC determines the 'numeri fixi' the University is applying for, being free to diverge from the wishes of the subfaculties and, of course, the EB. The UC can apply for 'numeri fixi' for subfaculties not wishing one and vice versa. The final decision is made by the Minister. He determines the 'numeri fixi', but can only do so if a University has expressed a wish to have one at one or more of its institutes. In this way, the freedom of the Minister is limited to refusing a 'numerus fixus' or to fixing the number of students a subfaculty most admit at a level which differs from the one that had first been proposed.

The Problem Definition:
Actual and Possible Numerus Fixus Policies

A close look at the problem-field reveals that the UCs did not just face a mere technical problem. Moreover, this technical problem is situated within a social context. So the new instititution of a UC was confronted with the complicated integrated technical and social problems, which are related to the capacity problem.

It is useful to take a look at the possible policies a UC can adopt anyhow. This allows us to get somewhat deeper into the capacity problem, in which we will embody the social element of the problem-field: the restrictions placed upon the possible UC-policies by the competences of other interested and authoritative groups.
The capacity problem can be considered to be made up of three

elements:
the capacity C of an educational institution, or, in other words, the number of students it can handle; the financial means M an institution has at its disposal; and its educational programme P, the knowledge, skills, and attitudes one wants the students to possess. The relations of C, M, and P, to one another can be expressed in the form of a mathematical formula:

$$C = M \times P$$

This formula allows for a distinction between the policies one can adopt with regard to the capacity.

The traditional policy, as we have seen, can be expressed as

$$P \times C \text{ —— } M$$

In words: given a certain educational programme and given a certain number of students, the necessary means are to be determined and, subsequent to this, to be furnished, being the dependent variable in the formula.

But since the late sixties, means, being 'frozen', have no longer been a dependent variable. In this situation, two other policies can be imagined:

$$M \times C \text{ —— } P\text{, and}$$
$$M \times P \text{ —— } C$$

Given a certain amount of means, one can either give priority to the capacity and adopt the educational programme, or regard this latter element as one that is not to be changed, in which case the capacity has to be adjusted.

The three policies mentioned, however, are not the only possible ways for handling capacity problems. The fact is that a 're-allocation policy' can be adopted, which aims at a redistribution of means in order to bring about an equal means/students ratio among the distinct subfaculties, combined with a more efficient use of the means.

This policy too can be derived from the CMP-cheme. It regards the (fixed) means of a university as a whole to be the sum of the means of the subfaculties: $M_u = M_{i1} + M_{i2} + \ldots$ These M_is, being the products of P x C of the individual subfaculties, are not regarded as individually fixed. In this way, a UC can indirectly force a subfaculty to change its educational programme, giving it a certain budget, and stating the number of students it has to admit, holding responsibility for the distribution of means over the subfaculties.

Why dit not the UCs succeed in quickly finding this solution? Probably the most important reason for this was the fact that the subfaculties, being responsible for their educational activities, regarded a policy M x C - P, forced upon them by higher authorities than themselves, as an infringement of their traditional autonomy in this area. And the UCs were ready to confirm this objection, their members - excluding the students, most of them backing the M x C - P policy as a temporary measure to cope with the situation they wanted to be altered as soon as possible - representing the subfaculties and defending their traditional rights.

The aim of the SUS Game is to investigate the possibilities of making a UC adopt an 'integrative policy' with regard to the 'numerus fixus' problem. The analysis of the referent system has shown that this will be more likely when some important changes in the voting system are made. So one of the possible designs of a SUS Game will be to simulate a UC being chosen by means of a different voting system. Thus, using one of the characteristics of simulation, a SUS Game will be an optimalisation game, rather than a mere replication.

The Design Process: What A SUS Game Should Be Like

Systems behaviour is fundamentally dependent on its environment. Or, in the case of SUS, in attaining its goals with regard to the educational system, a UC will have to inquire into the state of this system. When a UC has intervened in this system, it will have to inform itself on the results of its policy, to evaluate this information, and to decide whether further interventions are necessary or not. In formulating its policy a UC is not so much 'an island' in society, as 'an arena', in which different and often contradicting ideas and ideals are clashing. Well, what are the consequences of a design for SUS as a pure game? In a game, the group of players is confronted with a certain situation, which is represented by the 'rules of the game'. In the case of SUS, the players will be given information about the state of affairs in the educational system, they will receive applications for 'numeri fixi' from the subfaculties, they will be told that they are chosen by the distinct groups of the university community and should not regard themselves as representing faculties, and they will hear that they are expected to make a decision on what kind of application will be sent to the Minister. The same holds for a man-machine simulation. But this instrumentation offers some additional possibilities. Just to mention some of these, a subfaculty can protest against a decision the UC has made. The UC, having decided to intervence directly or indirectly in the educational system, can be given information about the effects of this decision. In this way, much of the feedback between UC and the other bodies is preserved.

But still, the question remains whether this is necessary. Incorporating a feedback possibility is only needed when it is probable that in the referent system a reaction on an action of the UC would reach that same UC, in which process some time delay is involved. In this review, a mere game is regarded as an acceptable instrumentation form only then, when it is certain that the length of time of the process one intends to simulate, does not exceed this time-delay.

In the case of the SUS Game, where one wishes to observe the behaviour of the UC in the new voting system for a considerable length of time, this condition cannot be met. So, a SUS Game, for this variety of reasons, must be a man-machine simulation.

4 What game should be built

If the SUS Game can stand as an example of a regular man-machine simulation, some conclusions can be drawn both from the way in which its final design was arrived at and from the results its execution produced.
In 4.1 we will present some conclusions with regard to the initial questions as posed in section 2 of this paper: 'What, if any, are the relations of function to instrumentation?"
In the next two sections, the same question will be narrowed to the purposes a man-machine simulation has to serve, theory-testing and instruction respectively, and the advantages of a man-machine simulation over other instrumentation forms will be exposed.

Instrumentation and Function

Reviewing some publications in the field of simulation, a tendency has been noticed to regard instrumentation form as intrinsically related to function. The SUS Game has, at least, clearly shown that this relation should not be seen as absolute. One instrumentation form, in this example a man-machine simulation, can be chosen for both theory-testing and optimalisation purposes and at the same time be of value for instruction ends.
Why, to pose the question in this way, should a theory-testing simulation imply another instrumentation form than an optimalisation simulation?
The difference between these two being the mere status of the model on the basis of which the simulation is designed - the replication of a past or present state of affairs versus that of a not (yet) existing situation - this by no means implies that the 'translation' of this model into elements of a simulation should be fundamentally different. The form in which the SUS Game was executed was that of an optimalisation game,

but had a slight difference been introduced - a 'normal' voting system instead of the 'experimental' one used in SUS - it would have been replicating an existing situation.

And what about the difference between a simulation which intends to test a theory or to optimise a certain situation on the one hand, and a simulation which is designed for pure instruction purposes on the other? It is likely, we think, that this difference too is anything but absolute. One of the most striking differences between the simulation technique and an experiment is the active role of the participants in a simulation. While most experiments seem to be based upon the simulus-response scheme of behaviourism, the simulationist recognizes the influence of the rational faculties on human behaviour. In this view, a course of action is the resultant of the goals one wants to achieve and of the situation: the available means and the obstructing conditions.

Well, a simulation which intends to copy a real-life decision process, as most simulations are designed to do, has to incorporate these elements in its rules of the game, as will be elaborated in the next sections.

The players are told what to do (the goals they have to achieve) and most of the other rules give information on the possibilities and impossibilities to do so. Therefore, this kind of simulation has to share some, or rather most, of the features of simulations which are mainly designed as instruction instruments. The condition for the success of a theory-testing instruction is the purpose of an instruction game. I.e., to give the players information about the situation in which they are supposed to act. The difference, then, between these kinds of simulation mainly consists in the fact that in the latter kind the action process is used as an instruction technique, while in the former it is in the cource of data, for the generation of which the simulation is designed and executed.

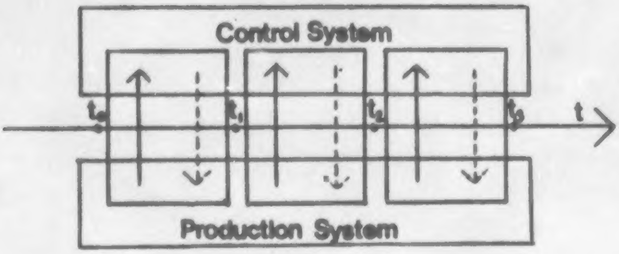
So, the often, mostly implicitly, stipulated difference between theory-testing, optimalisation, and instruction simulations in regard with their instrumentation forms seems to be, at most, a matter of varying emphasis put upon some elements of the game as compared to other parts. Which leaves just one legitimate ground for differences in the instrumentation form chosen: differences in the problem-field, which in combination with a different problem-definition should account for a different instrumentation form.

Instrumentation and the Referent System

Most simulations as used in the social sciences have their origin in the wish to study decision processes. The most general form these processes can assume is that of a control system which, in competition with other control systems or not, tries to alter or to maintain the state of some process according to the goals of that control system. In these control activities, information is of the first importance. First, using just one of the many schemes in this field, there is the syntactic information: the goals a system intends to achieve, their interrelations, and priority hierarchy. Secondly, one distinguishes the semantic information, which gives a system its necessary knowledge about its environment. And thirdly, the pragmatic information states the way in which a system can achieve its goals in that same environment.

In the case of a production system P, which stands in relation with just one control system C, those information flows can be imagined to run as follows:

At moment t_o, C receives semantic information (continuous lines) from P about the state of its production process. This information is compared with the goals of C (syntactic information) and, in the case of an intervention being desirable, C will 'emit' pragmatic information (interrupted lines) to P in order to correct the state of its production process. C, for checking the results of its intervention, is likely to inquire about the new state of the production process, say at moment t.



A new comparison of the semantic information with the syntactic will take place, and so on.

If this can be regarded as the general form a decision process adopts, on the basis of this scheme, then, one can determine which instrumentation form is most suited for a certain problem field.
If one wants to simulate just one 'decision loop', say from t_0 up to t_1, a game seems to be the most appropriate choice. For it not being necessary to replicate the way in which the production process alters under the unfluence of the decision of C, just the way in which C makes its decisions has to be simulated. This has to be done by using human players, for reasons mentioned before.
If, on the other hand, one wants to simulate more than one decision loop, e.g. from t_0 or t_3, it will be clear that one will be in need of a simulated P, and, in that way, of a man-machine simulation model. For, in this case, C is likely to want to have information about the effects of its decisions, and in other to be able to give C this information, one needs a machine model that can compute these effects.

A different situation comes into existence, when more than one control system C_1 either is confronted with the actions of C_2 because the state of P is also subject to C_2's decisions with regard to it, or C_2 tries to influence the actions of C_1 in a direct way, by trying to alter C_1's policy with regard to P.

Whatever the situation may be, a simulation model should have as many 'man parts' as there are distinct Cs standing in a 'multiple decision loop' relationship to C_1. Only when this demand has been met, can the simulation model be considered to be as dynamic as its referent system is. However much this may be true, this is too heavy a condition for most theory-testing and optimalisation simulations.

Sometimes, 'the game is not worth the candle', and all those Cs which are not under special consideration are represented by machine models, as was done in the SUS Game. At the same time, however, the pretentions of the game should be lowered to the level of accuracy at which the relevant components of the referent system and its environment have been simulated. Then, for example, not the exact results of the game, but rather the way in which the decisions were made can be regarded as reliable enough data to base upon one's conclusions.

Instrumentation And Instruction

The combination of problem-field and problem definition, so it has been argued, dictate the necessity of a man-machine simulation, whatever the function simulation has to serve. In the case of an instruction simulation, however, we would like to state the desirability of this man-machine simulation, besides the possible necessity of it, mindful of our thesis that function should not affect the design of a simulation model.

In the framework of this plea, it can be useful to distinguish between two different views on the purposes a learning technique has to serve.

'Instruction', to call it that, aims at increasing the amount of knowledge about some subject, whereas 'education' would rather aim at an improvement of the skills one has at one's disposal to cope with the 'outer world'. The latter aim being the more comprehensive one, we will use 'education' as a yardstick in our evaluation of the use the distinct instrumentations can have when simulation is assumed to serve this kind of purpose.

If education means giving someone more possibilities 'to cope with the outer world', we think this aim can be put in the more operational term 'to learn to handle one's environment in a satisfying way'. This presupposes not only knowledge of the ways in which one can adapt one's environment according to one's wishes, but also a process in which this same environment is being evaluated, is being interpreted in terms of the values one fosters. Not always, life learns us, as it clear whether we should value a situation positively or negatively, and the more so, when we are confronted with situations we are not acquainted with. Before the question of reacting to a situation can be raised, it has to be clear how that situation should be valued. Then it is essential to outline one's course of action, not only taking into consideration the possible effects of one's interventions, but also the possible reactions of others, who have also some interests in the same area.

Well, many of these processes, we think, underlie some of the most essential features of simulation, and especially those of man-machine simulation.
As must have become clear from some of the passages in which we have defended man-machine simulation for other reasons than its possible instruction value, the participants in this kind

of simulation are, within the limits set by the rules of the game, totally free to develop their policy. The games management furnishes just two kinds of information - syntactic and semantic -, leaving it up to them to 'translate' the semantic information in terms of the syntactic and to find out the best way to come to a solution for the problems they are confronted with.

Up to this point again, a game and a man-machine simulation can equally well be used as instrumentation forms. But as soon as it is regarded as desirable to give the players some information about the effects of their sections, as an important part of the education programme, the former turns out to be inadequate, not being able to generate feedback. Then, the man-machine simulation, being able to define a still static 'zero situation' as well as to introduce the dynamics of feedback, seems to be the most appropriate instrument for making its participants acquanted with th ins and outs of a situation on a 'learn-it-yourself' basis.

5 Epilogue

Let us review the several instrumentation forms and their specific characteristics and confront them with the pretentions ascribed to simulation. Essentially, simulation claims to be able to represent the evolution of its referent system, to research systems dynamics.
At the same time, it is subject to the demands of controllability like any other scientific method. The tension, existing between dynamics and controllability, seems to be the Achilles' heel of simulation. No simulation instrumentation form, we think, can completely cope with these two problems simultaneously.
Our discussions of the two forms of man simulation show that a pure game cannot include a process over time, respecting a

desirable representation of the feedback principle between control system, production system, and other relevant systems. At the same time, however, it is a quite reliable measure instrument: everything being static but the actions of the players, differences in its outcome can be ascribed only to them.
Whereas the pure game lacks relevance (and may be even, for the same reason, validity), the man-machine simulation faces difficulties concerning the question of controllability.
In this instrumentation form, no part of the simulation is static. A different outcome can indicate a different action of the machine part of the game as well as the man part of it. And maybe even its validity must be doubted: is it possible to foresee all actions of the players and programme an adequate response to them in the machine part?

So, it seems to be simulation's fate that its possiblities to meet the demands of controllability versus dynamics are inversely proportional to each other.

Acknowledgements

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